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CIVIL REMOTE SENSING SATELLITE SYSTEM

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HEARINGS

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

NINETY-SIXTH CONGRESS

SECOND SESSION

ON

TRANSITION PLANNING FOR THE OPERATIONAL CIVIL REMOTE SENSING SATELLITE SYSTEM

JUNE 26 AND JULY 24, 1980

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TRANSITION PLANNING FOR THE OPERATIONAL CIVIL REMOTE SENSING SATELLITE SYSTEM

THURSDAY, JUNE 26, 1980

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
Washington, D.C.

The subcommittee met at 11:15 a.m. in room 235 of the Russell Senate Office Building, Hon. Adlai E. Stevenson (chairman of the subcommittee) presiding.

Senator SCHMITT. The committee's hearing will come to order.

This morning, the Senate Subcommittee on Science, Technology, and Space will conduct its initial hearing on the transition planning for an operational remote sensing satellite system.

Senator Stevenson will be with us shortly.

OPENING STATEMENT BY SENATOR STEVENSON

Senator STEVENSON [presiding]. On November 16, 1979, in a document known as Presidential Directive/NSC-54, the President approved a civil space policy in which he assigned to the National Oceanic and Atmospheric Administration of the Department of Commerce the management responsibility for operational land remote sensing activities. He also directed that the initial operational land remote sensing satellite system would be based on Landsat technology to maintain the continuity of data; and that the Department of Commerce's initial responsibility, in coordination with other appropriate agencies, would be to develop a time phased transition plan.

The President also directed that the transition plan would cover certain specific activities and established the goal of eventual operation by the private sector of civil land remote sensing activities.

Further, he directed that Commerce would budget in fiscal year 1981 to seek ways to enhance private sector opportunities. PD-54 also established other policies with respect to civil space remote sensing activities.

Without objection, a number of documents relating to PD-54 will be entered into the record as an appendix. In addition, earlier policy statements issued by the President dated June 1978 and October 1978 will be made part of the record in the appendix.[1]

Both Senator Schmitt, the ranking minority member on this subcommittee, and I have introduced bills S. 875 and S. 663, respec-

[1] See p. 169.

tively, to establish the operational system. Hearings on these bills were held last year on April 9 and 11 and again on July 31.

PD-54 was a welcome move. For years the committee, and the predecessor Aeronautical and Space Sciences Committee, have been urging the administration to move to an operational land remote sensing satellite system. NASA's experimental Landsats have demonstrated the enormous usefulness of satellite land remote sensing data for the management of the Earth's resources and environment.

The purpose of the hearing today is to take testimony on the transition plan so that we can understand how the administration proposes to move from the current experimental systems to an operational system.

In order for the National Oceanic and Atmospheric Administration to carry out the President's direction as established by PD-54, it would of course be necessary that funds be authorized and appropriated to NOAA to accomplish this task. Our understanding is that the Office of Management and Budget has thwarted NOAA's requests for funding for fiscal years 1980 and 1981, making only minimal amounts available. Clearly, without adequate funds NOAA cannot carry out the President's directive and will have to wait until at least fiscal year 1982. The subcommittee will be interested to learn precisely what the budget situation is.

The "Transition Plan for Civil Operational Land Remote Sensing from Space" has not been formally transmitted to the committee, although they did make available to the subcommittee a censored version. Without objection, that document will be printed in the hearing record as an appendix.[2]

I further direct the staff to have these hearings printed as quickly as possible so that they will be available soon to all interested parties.

Senator Schmitt?

Senator SCHMITT. I wonder if we should not have Dr. Frosch, Mr. Frank, and Mr. Johnson come forward and all be at the table at the same time.

I think we appropriately, since the responsibility for this transitional planning has been with the National Oceanic and Atmospheric Administration, would ask Mr. Frank, the Administrator of that organization, to begin the testimony.

Now does anybody have a time problem? Dr. Frosch, I saw you sitting there as if you were anxious.

Dr. FROSCH. No.

Senator SCHMITT. We will try to move as quickly as we can, but I do not want to——

Mr. FRANK. He has to be back for the Space Shuttle launch. Other than that——

Senator SCHMITT. I am not sure that with your dependency on NASA launch vehicles, snide comments like that would be in order. However, your choice.

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[2] See p. 169.

STATEMENTS OF RICHARD A. FRANK, ADMINISTRATOR; DAVID JOHNSON, CHAIRMAN, SATELLITE TASK FORCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, DEPARTMENT OF COMMERCE; AND DR. ROBERT A. FROSCH, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. FRANK. Senator, thank you.

I am pleased to appear before you today to discuss the planning for a civil operational land remote sensing satellite system. With me, as you have mentioned, is David Johnson, Director of the National Environmental Satellite Service and the NOAA land remote sensing satellite task force.

The last 8 months have marked a new era in U.S. land remote sensing from space. In addition to Presidential decisions that you are aware of, last November President Carter designated a single agency, NOAA, to manage all civil operational remote sensing satellite activities and directed the preparation of a transition plan for moving to a satellite based land remote sensing program.

Before addressing the key programmatic, organizational, and financial issues that will need resolution in the transition to an operational system, I would like to review briefly the Department's activities in this field since I last testified before you.

In my testimony before you on February of 1980 I discussed the Presidential decision in November of 1979 which instructed the Department of Commerce to prepare a time-phase transition plan proposing ways to move from the largely experimental Landsat program, to a civilian operational land remote sensing satellite system.

This decision provided the framework for implementing policies announced to this committee in 1979 by the President's Science Adviser, Dr. Frank Press, that the administration "is committed to the continuity of remote sensing data for civil applications through the 1980's," and that "the administration is committed to an operational remote sensing system, although yet undefined."

In developing the transition plan we have made extensive efforts to assure the full involvement of non-Federal users and potential private sector system operators.

I have listed these activities for the involvement of non-Federal users and potential private sector system operators in the testimony. They are extensive and involve, to my knowledge, the widest amount of public participation in this area that has ever taken place.

A final administration position on these subjects will be completed through the 1982 budget review process. I would like to submit for the record a document entitled, "Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options." [1]

This document presents the issues that must be addressed in the implementation of the Federal Government's policies on a civil operational land remote sensing satellite system.

Aside from leading the effort to prepare the transition plan, the Department has taken a number of steps to assure the achieve-

[1] See p. 176.

ment of the President's objectives. The Presidential decision assigned to NOAA responsibility for managing the civil operational land remote sensing satellite activities.

The Department has also requested the reprograming of $800,000 to initiate the development of a civil operational land remote sensing satellite program pending passage of a $1 million fiscal year 1980 supplemental budget request, and a $1.2 million appropriation for fiscal year 1981 to fund the initial NOAA effort in this area.

Finally, the Department submitted an administration bill on March 26, 1980, to authorize NOAA to plan and provide for the development and operation of a civilian space based Earth remote sensing system.

Although NOAA has authority to operate environmental and meteorological satellites, explicit authority to plan for, develop, and operate a civilian space based Earth remote sensing system is desirable.

The Department of Commerce is committed to the effective implementation of a civilian operational land remote sensing satellite system. Other agencies support this effort. Because of the basic importance of this program and the resources required for its implementation, Congress should pass upon this issue. I urge Congress to enact the authorization and appropriations requested by the administration.

Let me turn now to the key issues in developing an operational system.

The Federal Government currently contemplates a two-phase development of a civilian operational land remote sensing satellite capability. An operational system designed from the beginning to meet the four technical performance standards identified for a high quality operational system can be implemented, at the earliest, in 1989 when the R. & D. necessary for the new solid state multilinear array sensors should have been completed, and the sensors will have been fabricated, tested on a Shuttle flight now planned for 1986, and incorporated into either the existing multimission modular spacecraft, or a new spacecraft. The system so modified is designated by us "the fully operational system."

Extension of the Landsat-D system can insure that the commitment to continuity of data during the decade of the 1980's is met. This Landsat-D system, with any followon satellites and ground system improvements, has been designated "the interim operational system." NOAA will manage the interim operational system in coordination with an Interagency Program Board and a Land Remote Sensing Satellite Advisory Committee. Establishing these operational systems with the goal of eventual private sector ownership and operation will require resolution of a number of issues. Let me address these issues in turn:

First, what changes, if any, are necessary in the current plans for the NASA Landsat-D system to provide adequate performance as an interim operational system? The attachment to my statement of February 21, 1980, described in some detail the wide range of uses for land remote sensing satellite data for producing information on renewable and nonrenewable resources, and for studying environmental quality and land use. From a technical standpoint,

we have identified four performance standards as applicable to a high quality operational land remote sensing satellite system.

First, sensors designed to generate data meeting a broad range of user requirements at a reasonable price;

Second, assured continuity of satellite coverage without break, with one backup satellite in orbit at all times, and another on the ground;

Third, 95 percent confidence that, averaged over a 2-day period, all data will be processed and made available from the ground station within 48 hours of receipt;

And fourth, ability to identify and process certain data out of order to meet urgent user needs.

For the interim operational system, the satisfaction of the first performance standard is dependent on the capabilities of the Landsat-D sensors, which cannot be altered significantly until the late 1980's. The Landsat-D sensors will be able to accommodate many user needs.

In other areas, improvements may be required to insure data continuity during the 1980's. For instance, the current Landsat system includes no satellites after Landsat-D. Anticipated gaps in spacecraft coverage of several years between about 1986 and the initiation of a fully operational system may have to be filled by the construction of one or more satellites, or by the refurbishment of Landsat-D.

In addition, changes in the Landsat-D ground segment may be required to minimize the risk of losing data or having an excessively long delay in processing some data. The administration and Congress should address these issues in the development of the fiscal year 1982 budget.

Second: What performance capability should be designed into the next generation fully operational system?

NESS Director Johnson has outlined the technical options for the fully operational system in his written testimony. I will only note that the difference in cost between the system alternatives is substantial, varying from about $1 billion over a 10-year period to as much as 10 times that amount if 2-meter resolution is to be provided. The resolution of the current Landsats is 80 meters.

The extent to which the performance standards described earlier are pursued in a fully operational system will depend upon their capital and operating costs and the demonstrated existence of an adequate private and Federal market to justify such costs.

A decision on when to implement the fully operational system requires careful examination of the Federal Government's priorities, needed financial assistance, private sector willingness to invest in and operate the system, user demands during the interim operational system, and the potential risk of foreign satellite systems obtaining a portion of the domestic and foreign land remote sensing market.

Third: What policies should be adopted to provide financing for the interim and fully operational systems?

Reliable projections of revenues from sales of standard data products and from the direct reception fees to be paid by foreign ground station operators cannot be made at this time. However, tentative projections indicate that these systems, even with increases in fees,

may not and probably will not be self-financing before the end of the century. This revenue gap, especially over this decade, will have to be filled by some Federal financial support for the system.

To achieve the objectives for the sharing of costs by users and for the eventual ownership and operation by the private sector, prices must be increased to cover over time the capital and operating costs of the system. Establishment of prices that recover more than the cost of data reproduction can only be effective if the system operator is authorized to keep others from reproducing and distributing standard data products at lower prices.

Congress will need to consider whether legislation is desirable that would establish ownership rights in the data and standard data products, and exempt them from the cost of reproduction fees prescribed by the Freedom of Information Act.

At the same time, the administration and Congress must decide whether, and if so, what type of market expansion program should be undertaken by the system operator, to increase revenues, reduce required Federal financial assistance, and enhance decisionmaking through the use of land remote sensing satellite data.

A market expansion program for the operational system can build on the types of training and technology transfer activities now being conducted by NASA and the Department of the Interior.

However, Federal marketing efforts on a scale sufficient to reduce significantly the required federal assistance would be an expansion of the Federal role on a significantly larger scale than the types of training and technology transfer activities now being conducted by NASA and the Department of the Interior, and may be activities better left to an eventual private sector operator. Planning for any appropriate market expansion activities will be addressed in future budgetary decisions.

Since a substantial shortfall is projected between annual revenues and the estimated annual cost of running an operational system of up to $400 million per year, Federal financial support likely will be required for the foreseeable future. There are various forms this support could take, and we have outlined them in the document provided you.

Three possible options for Federal user agencies to share in the costs of financing the operational land remote sensing system have also been set forth in the issues document provided you.

A decision on the preferred financing option will weigh, on the one hand, the benefits of having a mechanism that forces the user agencies to make tradeoffs between land remote sensing satellite data and other data sources, and on the other hand, the advantages of focusing responsibility for the program and budgeting in one agency.

Because it expects to use more than half of the data and standard data products for the near-term future, the Federal Government, and ultimately the taxpayers, will be paying a majority of the cost of an operational land remote sensing satellite system, whatever options are chosen for pricing and for Federal financial assistance for capital and operating costs. The administration's budget and legislative proposals for the next Congress will address these issues.

Fourth, how can eventual private sector ownership and operation best be achieved?

Private sector operation of the U.S. civil operational land remote sensing satellite system—as distinguished from Government operation either directly or through a contractor—includes the assumption of a degree of financial risk, as well as operational control, by one or more private sector entities. Four principal institutional options for achieving eventual private sector involvement have been considered in the administration's planning:

First, a private corporation, or consortium, selected competitively to own and operate all or part of the system and to sell data to Federal agency users under a guaranteed purchase contract.

Second, a for-profit corporation authorized by specific Federal legislation with private equity and privately and publicly appointed board members.

Third, a wholly owned Government corporation authorized by specific Federal legislation with Government equity reporting to the Secretary of Commerce, with provision for eventual transformation to a private stock corporation as system revenues warrant.

And finally, Federal agency ownership with private contractor operation and provision for subsequent transfer to a private sector owner as system revenues warrant.

The discussion document that I have provided the subcommittee discusses the pros and cons of these options in detail, and I will not attempt to summarize them here.

Options one and two, of course, offer the earliest possibilities of private sector ownership and assumption of risk. Options three and four delay implementation of private sector ownership until the next decade.

These options will be examined by the administration to evaluate which alternative best serves the Federal, State, and local government and private sector interests in having an operational land remote sensing satellite program.

One advantage of early identification of the entity that is to own and operate the fully operational system is that the entity can play a role in the technical design and establishment of the operational system that it will manage. While early identification of an entity would allow it to participate in the planning and design of a fully operational system, it may be desirable on the other hand to delay selection of an entity until a better assessment of possible private sector participation can be made on the basis of initial experience with the interim operational system.

If ownership and operation are transferred to an entity other than the Federal Government, the entity's activities should be regulated to the extent necessary to conform to national space and other domestic and foreign policy objectives.

A private or Government entity owning the operational system should be required, for example, to comply with international treaties such as the Outer Space Treaty for the conduct of peaceful activities in outer space, continue the widest practical dissemination of data and standard data products on a public, nondiscriminatory basis; meet the needs of U.S. Government users; and refrain from misuse of insider knowledge obtained from land remote sensing satellite data.

The administration and Congress will need to consider these issues of regulation in their evaluation of the involvement of the private sector in the ownership and operation of the operational land remote sensing satellite system.

Finally, how should U.S. plans for an operational system be interrelated with the land remote sensing satellite plans of other countries?

The United States has long encouraged international participation in the U.S. experimental land remote sensing program. Now for the first time, other nations—including France and Japan—are planning land remote sensing satellite systems to begin in the mideighties. Some will incorporate sensors more advanced than those on Landsat-D.

These systems offer the prospect of both competition and cooperation with the United States. They will provide competition in sensor technology development and in sales of ground equipment, services, data, and standard data products.

At the same time, they present opportunities for complementary characteristics and compatible system outputs that could enhance the value of each of these systems for the global user community, and broader market development.

We have begun discussions with other potential system operators to determine the extent to which it may be possible to have this international collaboration.

In conclusion, Mr. Chairman, careful attention to the proper resolution of these issues by the administration and Congress will be rewarded by significant benefits to the Nation. We look forward to working with you in the development of an effective program for establishing a civil operational land remote sensing satellite system.

This concludes my prepared statement. I would be happy to answer any questions you may have now or after the statements are made.

[The statement and answers to questions of the committee follow:]

STATEMENT OF RICHARD A. FRANK, ADMINISTRATOR, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Mr. Chairman and Members of the Committee, I am pleased to appear before you today to discuss the planning for a civil operational land remote sensing satellite system. With me is David Johnson, Director of the National Environmental Satellite Service and the NOAA Land Remote Sensing Satellite Task Force.

The last eight months have marked a new era in U.S. land remote sensing from space. Last November, President Carter designated a single agency, NOAA, to manage all civil operational remote sensing satellite activities and directed the preparation of a transition plan for moving to a satellite based land remote sensing program.

Before addressing the key programmatic, organizational and financial issues that will need resolution in the transition to an operational system, I would like to review briefly the Department's activities in this field since I last testified before you.

I. ACTIVITIES TO IMPLEMENT THE PRESIDENTIAL DECISION ON LAND REMOTE SENSING SATELLITES

In my testimony before you on Februry 21, 1980, I discussed the Presidential decision in November 1979, which instructed the Department of Commerce to prepare a time-phased Transition Plan proposing ways to move from the largely experimental Landsat program to a civilian operational land remote sensing satellite

system. This decision provided the framework for implementing policies announced to this Committee in 1979 by the President's Science Advisor, Dr. Frank Press, that the Administration "is committed to the continuity of remote sensing data for civil applications through the 1980's," and that "the Administration is committed to an operational remote sensing system, although yet undefined."

In developing the Transition Plan, we have made extensive efforts to assure the full involvement of non-Federal users and potential private sector system operators. Five conferences on the proposed U.S. operational land remote sensing satellite program were held to obtain information on the needs of present and potential domestic non-Federal users of land remote sensing satellite data in Washington, D.C.; Seattle, Washington; Chicago, Illinois; Albuquerque, New Mexico; and Tallahassee, Florida. Over twenty thousand announcements were sent out, and over 750 representatives of user groups attended these conferences and participated actively in topical working group sessions where user requirements were discussed in detail. Over 200 questionnaires were gathered and are being analyzed as a basis for further refining non-Federal user requirements. Two workshops were held with private sector representatives who expressed interest in playing a role in the development, financing and operation of an operational land remote sensing satellite system. In addition, NOAA representatives made presentations to a number of professional society conferences, to the National Advisory Committee on Oceans and Atmosphere and to other organizations to explain the Administration's program and to receive guidance on program development.

The Transition Plan is the product of a cooperative interagency effort, which involved other agencies:

At the technical level through personnel detailed from other agencies to the NOAA Land Remote Sensing Satellite Task Force;

Finally, the Department submitted an Administration bill on March 26, 1980, to authorize NOAA to plan and provide for the development and operation of a civilian space-based earth remote sensing system. Although NOAA has authority to operate certain environmental and meteorological satellites, explicit authority to plan for, develop, and operate a civilian space-based earth remote sensing system is desirable.

I want to assure you that the Department of Commerce is committed to the effective implementation of a civil operational land remote sensing satellite system. Because of the basic importance of this program and the resources required for its implementation, Congress should pass on this issue. I urge Congress to enact the authorization and appropriations requested by the Administration.

II. KEY ISSUES IN DEVELOPING AN OPERATIONAL SYSTEM

The Federal government currently contemplates a two phase development of a civilian operational land remote sensing satellite capability. An operational system designed from the beginning to meet the four technical performance standards identified for a high quality operational system can be implemented at the earliest in 1989, when the R&D necessary for the new solid state, multilinear array sensors should have been completed, and the sensors will have been fabricated, tested on a Shuttle flight now planned 1986, and incorporated into either the existing multimission modular spacecraft or a new spacecraft. The system so modified is designated the Fully Operational System. Extension of the Landsat D system can ensure that the commitment to continuity of data during the decade of the 1980s is met. This Landsat D system, with any follow-on satellites and ground system improvements, has been designated the Interim Operational System. NOAA will manage the Interim Operational System in coordination with an interagency Program Board and a Land Remote Sensing Satellite Advisory Committee.

Establishing these operational systems with the goal of eventual private sector ownership and operation will require resolution of a number of issues. Among them are the following:

What changes, if any, in the current plans for the NASA Landsat D system should be made to improve its performance as an Interim Operational System?

What performance capabilities should be designed into the next generation Fully Operational System and when should it be implemented?

What policies and programs should be adopted to provide financing for the Interim and Fully Operational syatems?

How can eventual private sector ownership and operation best be achieved?

How should U.S. plans for an operational system be interrelated with the land remote sensing satellite system plans of other nations?

Let me address these issues in turn.

A. What changes, if any, are necessary in the current plans for the NASA Landsat D system to provide adequate performance as an Interim Operational System?

The Attachment to my statement of February 21, 1980, described in some detail the wide range of uses for land remote sensing satellite data for producing information on renewable and nonrenewable resources and for studying environmental quality and land use. From a technical standpoint, we have identified the following performance standards as applicable to a high quality operational land remote sensing satellite system:

Sensors designed to generate data meeting a broad range of user requirements at a reasonable price;

Assured continuity of satellite coverage without break, with one backup satellite in orbit at all times, and another on the ground;

95 percent confidence that, averaged over a two day period, all data will be processed and made available from the ground station within 48 hours of receipt; and

Ability to identify and process certain data out of order to meet urgent user needs.

For the Interim Operational System, the satisfaction of the first performance standard is dependent on the capabilities of the Landsat D sensors, which cannot be altered significantly until the late 1980s. The Landsat D sensors will be able to accommodate many user needs.

In other areas, improvements may be required to ensure data continuity during the 1980's. For instance, the current Landsat system includes no satellites after Landsat D'. Anticipated gaps in spacecraft coverage of several years between about 1986 and the initiation of a fully operational system may have to be filled by the construction of one or more satellites or by the refurbishment of Landsat D. In addition, changes in the Landsat D ground segment may be required to minimize the risk of losing data or having an excessively long delay in processing some data. The Administration and Congress should address these issues in the development of the fiscal year 1982 budget.

B. What performance capabilities should be designed into the next generation Fully Operational System?

NESS Director Johnson will outline the technical options for the Fully Operational System in his testimony. I will only note that the difference in cost between the system alternatives is substantial, varying from about $1 billion over a 10-year period to as much as ten times that amount if 2 meter resolution is to be provided. (The resolution of the current Landsats and the planned Landsat D is 80 meters.) The extent to which the performance standards described earlier are pursued in a Fully Operational System will depend upon their full capital and operating costs and the demonstrated existence of an adequate private and Federal market to justify such costs.

A decision on when to implement the Fully Operational System requires careful examination of the Federal government's priorities, needed financial assistance, private sector willingness to invest in, and operate the system, user demands during the Interim Operational System and the potential risk of foreign satellite systems obtaining a portion of the domestic and foreign land remote sensing market.

C. What policies should be adopted to provide financing for the interim and fully operational systems?

Reliable projections of revenues from sales of standard data products and from the direct reception fees to be paid by foreign ground station operators cannot be made at this time. However, tentative projections indicate that these systems even with increases in fees, may not and probably will not be self-financing before the end of the century. This revenue gap, especially over this decade, will have to be filed by some Federal financial support for the system.

To achieve the objectives for the sharing of costs by users, and for the eventual ownership and operation by the private sector, prices must be increased to cover, overtime, the capital and operating costs of the system. Establishment of prices that recover more than the cost of data reproduction can only be effective if the system operator is authorized to keep others from reproducing and distributing standard data products at lower prices. Congress will need to consider whether legislation is desirable that would establish ownership rights in the data and standard data products and exempt them from the "cost of reproduction" fees prescribed by the Freedom of Information Act.

At the same time, the Administration and Congress must decide whether, and if so, what type of market expansion program should be undertaken by the system operator to increase revenues, reduce required Federal financial assistance, and enhance decision-making through the use of land remote sensing satellite data. A

market expansion program for the operational system can build on the types of training and technology transfer activities now being conducted by NASA and the Department of the Interior. However, Federal Marketing efforts on a scale sufficient to reduce significantly the required Federal assistance would be an expansion of the Federal role a significantly larger scale than the types of training and technology transfer activities now being conducted by NASA and the Department of the Interior, and may be activities better left to an eventual private sector operator. Planning for any appropriate market expansion activities will be addressed in future budgetary decisions.

Since a substantial shortfall is projected between annual revenues and the estimated annual costs of running an operational system up to $400 million per year, Federal financial support likely will be required for the foreseeable future. Three possible options for Federal user agencies to share in the costs of financing the operational land remote sensing system might be considered:

User agencies could fund individually a predetermined portion of all "core" and special system costs;

NOAA could budget for core system costs and user agencies could budget for special system capabilities; and

NOAA could budget both for the core system, which includes the space and ground segment elements necessary to meet the common needs of the majority of users, and for the costs of special systems, such as stereoscopic coverage;

A decision on the preferred financing option will weigh, on the one hand, the benefits of having a mechanism that forces agencies to make trade-offs between land remote sensing satellite data and other data sources and, on the other hand, the advantages of focusing responsibility for the program and budgeting in one agency. Because it expects to use more than half of the data and standard data products over the near term future, the Federal government, and ultimately the taxpayers, will be paying a majority of the costs of an operational land remote sensing satellite system whatever options are chosen for pricing and for Federal financial assistance for capital and operating costs.

The Administration's budget and legislative proposals to the next Congress will address these issues.

D. How can eventual private sector ownership and operation best be achieved?

Private sector operation of the U.S. civil operational land remote sensing satellite system, as distinguished from government operation either directly or through a contractor, includes the assumption of a degree of financial risk as well as operational control, by one or more private sector entities. Four principal institutional options for achieving eventual private sector involvement have been considered in the Administration's planning:

(1) A private corporation (or consortium) selected competitively to own and operate all or part of the system and to sell data to Federal agency users under a guaranteed purchase contract;

(2) A for-profit corporation authorized by specific Federal legislation, with private equity and privately and publicly appointed Board members:

(3) A wholly-owned government corporation authorized by specific Federal legislation, with government equity, reporting to the Secretary of Commerce, with provision for eventual transformation to a private stock corporation as system revenues warrant; and

(4) Federal agency ownership with private contractor operation and provision for subsequent transfer to a private sector owner as system revenues warrant.

The Discussion Document that I have provided the Subcommittee discusses the pros and cons of these options in detail, and I will not attempt to summarize them here. Options 1 and 2 offer the earliest possibilities of private sector ownership and assumption of risk. Options 3 and 4 delay implementation of private sector ownership until the next decade.

These options will be examined by the Administration to evaluate which alternative best serves the Federal, state and local government and private sector interests in having an operational land remote sensing satellite program.

The entity, whether Federal or private, that is to own and operate the Fully Operational System should be identified sufficiently in advance of any target operating date that the entity can play a role in the technical design and establishment of the operational system that it will manage. While early identification of an entity would allow it to participate in the planning and design of a Fully Operational System, it may be desirable to delay selection of an entity until a better assessment of possible private sector participation can be made on the basis of initial experience with the Interim Operational System.

Finally, if ownership and operation are transferred to an entity other than the Federal government, the entity's activities should be regulated to the extent neces-

sary to conform to national space and other domestic and foreign policy objectives. A private or government entity owning the operational system should be required, for example, to comply with international treaties such as the Outer Space Treaty for the conduct of peaceful activities in outer space; continue the widest practical dissemination of data and standard data products on a public nondiscriminatory basis; and meet the needs of U.S. government users; and refrain from misuse of insider knowledge obtained from land remote sensing satellite data.

The Administration and Congress will need to consider these issues of regulation in their evaluation of the involvement of the private sector in the ownership and operation of the operational land remote sensing satellite system.

E. How should U.S. plans for an operational system be interrelated with the land remote sensing satellite plans of other nations?

The United States has long encouraged international participation in the U.S. experimental land remote sensing program. Now for the first time other nations, including France and Japan, are planning land remote sensing satellite systems to begin in the mid-1980s. Some will incorporate sensors more advanced than those on Landsat D. These systems offer the prospect of both competition and cooperation with the U.S. They will provide competition in sensor technology development and in sales of ground equipment, services, data and standard data products. At the same time, they present opportunities for complementary system characteristics, compatible system outputs that could enhance the value of each of these systems to the global user community, and broader market development.

We have begun discussions with other potential system operators to determine the extent to which it may be possible to—

Maximize the potential usefulness of U.S. and foreign land remote sensing satellite data for U.S. users as well as users in other countries;

Minimize the duplicative aspects of foreign satellites by encouraging the development of foreign capabilities that complement U.S. programs; and

Limit U.S. space segment costs by avoiding unnecessary expenditures for missions that will be undertaken by other countries, so long as this does not result in undesirable U.S. dependence on foreign space capabilities.

III. CONCLUSION

Careful attention to the proper resolution of these issues by the Administration and Congress will be rewarded by significant benefits to the nation. We look forward to working with you in the development of an effective program for establishing a civil operational land remote sensing satellite system.

This concludes my prepared statement. I will be happy to answer any questions you may have.

QUESTIONS OF THE COMMITTEE AND THE ANSWERS THERETO

DATA CONTINUITY

Question. There is a great deal of emphasis on insuring the continuity of data during the 1980's. Realistically, do you think that is possible considering the condition of Landsats 2 and 3 and the proposed 1982 schedule for launching Landsat D?

Answer. While it is possible that Landsat 2 or 3 may continue in operation until the launching of Landsat D, it is not very likely considering their age. This could lead to a gap in coverage between the demise of both Landsat 2 and 3 and the launch of Landsat D.

Question. What in your judgment is the best course of action to minimize the data gap?

Answer. At this time, the only spacecraft that can be considered for launch in a manner to minimize a data gap is Landsat D. The course of action preferred at the present time by NASA, namely launching Landsat D without the thematic mapper (TM), appears to be the best course of action provided it does not delay significantly the test of TM.

Question. What is the situation if Landsat D should fail at launch or shortly thereafter?

Answer. Should Landsat D fail prematurely, the only recourse that would be available to NASA would be to launch Landsat D' when it became available and after any corrective action has been taken as a result of the failure investigation. Should Landsat D fail at launch or shortly thereafter the probability of an interruption in the continuity of data would be increased.

NATIONAL POLICY—PROPRIETARY RIGHTS

Question. The Transition Plan was developed in accordance with certain assumptions. One of these assumptions reads as follows: "The practice of the widest possible dissemination of Landsat data on a public, non-discriminatory basis will be continued for the data and standard data products from the Interim and Fully Operational Systems in accordance with prevailing U.S. national policies" What are these "prevailing U.S. national policies?"

Answer. As announced by U.S. representatives for the United Nations Committee on the Peaceful Uses of Outer Space, "the policy of the United States Government from the very beginning of our experimental remote sensing program has been to make available to any and all interested parties as promptly as feasible all data received from the (Landsat) satellites." (Statement by Ronald F. Stowe, United Nations Representative to the Legal Subcommittee of the UN Committee on the Peaceful Uses of Outer Space, May 21, 1976.)" The U.S. will continue to provide Landsat-type data to foreign users on an open, non-discriminatory basis. "(Statement on Remote Sensing, Kenneth S. Pedersen, Chairman, U.S. Delegation to the Scientific and Technical Subcommittee of the UN Committee on the Peaceful Uses of outer space, February 4, 1980.) This policy is consistent with Presidential directives, International treaty and Federal law. In the course of establishing the direction of U.S. civil space programs, President Carter announced, in a Press Release of June 19, 1978, that "data and results from the civil space programs will be provided the widest practical dissemination to improve the condition of human beings on earth and to provide improved space services for the United States and other nations of the world." This policy is also consistent with the principles of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (the Outer Space Treaty, TIAS 6347) which was adopted in the belief that "the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development." In addition, the Landsat program has been conducted by the National Aeronautics and Space Administration (NASA) in the spirit of NASA's statutory mandate to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof" (42 U.S.C. 2473). Lastly, the Freedom of Information Act's standard of public availability of agency records and information has influenced the Federal government's practice for dissemination of Information from the Landsat program.

Question. At certain points the Plan mentions proprietary rights in data and standard data products. What is meant by that? Who would hold these proprietary rights?

Answer. By proprietary rights, the discussion document means ownership rights in land remote sensing satellite data and standard data products. Heretofore, Landsat data and data products have been dissemination widely to domestic and foreign users, at the cost of reproduction or through nominal direct access fees, without any control over their subsequent distribution or reproduction. To recover the costs, both capital and operating, of the operational system may require a change in existing practice so that the system owner, including an eventual private owner, will be able to own the output of the system and control its subsequent distribution. Proprietary or ownership rights still would be exercised subject to the national policy of the widest possible dissemination of land remote sensing data on a public, non-discriminatory basis. Such rights could be held by the Federal system owner or the private system owner in accordance with the conditions prescribed by Federal law.

INTERIM OPERATIONAL SYSTEM

Question. Would you please explain the Interim Operational System as you recommended it in the transitional plan? How many satellites would be in orbit at any one time? How many would be operating?

Answer. The Administration will recommend the configuration of the Interim Operational System as part of its fiscal year 1982 budget request. The system will be based upon Landsat D technology. The number of satellites in orbit and operating at any one time will be determined by cost and the importance of the benefits to be provided to users, including Federal agencies.

Question. Will that give the repetitive coverage needed by the users?

Answer. Renewable resource users need repeat coverage about once every five-to seven days during the growing season; other user groups generally require seasonal coverage. To obtain repeat coverage once every five-to-seven days would require, as a minimum, two operating satellites with some capability to orient the sensors with respect to the earth's surface. The latter capability is not available on the Landsat D series.

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Question. Will the Landsat Ds have tape recorders aboard? Why? How large is the zone of exclusion?

Answer. Landsat D itself will not have tape recorders aboard; however, NOAA has recommended and NASA is considering adding tape recorders to Landsat D'. Tape recorders are needed to provide backup data capability in the event of scheduling conflicts in the Tracking and Data Relay Satellite System (TDRSS). Additionally they would provide coverage of the "zone of exclusion," which is the area of the Indian subcontinent and should central USSR.

Question. What is the total estimated cost of the proposed Interim Operational System?

Answer. The total costs of the proposed Interim Operational System cannot be estimated until a specific configuration is recommended by the Administration as part of its fiscal year 1982 budget request.

Question. Does the Interim Operational System include the recovery and relaunching of any of the Landsat Ds?

Answer. One of the alternatives being considered is to recover, refurbish, and relaunch one or more of the satellites in the Landsat D series.

ARCHIVING OF REMOTE SENSING DATA

Question. With respect to the EROS Data Center, will users—both Government and private sector users—continue to have access to the large archive of aircraft data?

Answer. Implementation of the transition to an operational land remote sensing satellite program will not impact the ability of both government and private sector users to obtain aircraft data from the archive in the EROS Data Center.

Question. Why not archive all remote sensing data at one central location so that users can go to one place and find that what is available in terms of remote sensing data?

Answer. Archiving all land remote sensing data at one location would require a facility and staff much larger and more complex than that required for Landsat data. Not even the EROS Data Center maintains an archive of all land remote sensing data at one central location. The Center itself supports the data information system used by the United States Geological Survey's National Cartographic and Information Center which maintains a catalogue of available data and redirects users to the relevant archive facility anywhere in the United States, including the EROS Data Center. Co-location of land remote sensing data with meteorological and oceanic remote sensing data would present even greater logistical problems, although such a possibility exists within NOAA due to its new responsibility for all operational remote sensing satellite data.

There are many sources of aircraft data, government and private, in the United States. It also is very costly to properly archive because of the large variety of formats and supporting data. It would be very costly to bring all these date into a common form in a single location. A more cost-effective solution may be to provide a computer-based catalog-access system whereby users can easily determine the type, quality and location of the aircraft data which is available to the public.

USER SYSTEM INTERFACE

Question. How do you plan to interface with the user community outside of the Government so that the operational system can be designed to meet the needs of these users?

Answer. NOAA will continue its efforts to develop a close working relationship with these users and to improve its understanding of their requirements. An office designated to serve as the focal point for this activity will be established within the National Environmental Satellite Service (NESS). The Land Remote Sensing Satellite Advisory Committee, with membership from the interested domestic non-Federal community, is planned to be established by the Department of Commerce in fiscal year 1981. The Advisory Committee will thus become available as an additional avenue to users, as well as being a source of advice and guidance on priority and policy issues that arise in connection with the needs of non-Federal users.

These users are diverse in terms of their outlooks, disciplines, resources and needs. Their willingness to cooperate with NOAA in working towards the specification of the fully operational system has been uniform, however. To discover and understand these needs completely, NOAA will depend upon continued user cooperation as, together, we develop an agreed range of system options that limit requirements in a technically sound way. With this range of options as a reference, it will become easier to aggregate requirements and to assign them weighted values. The process will involve meetings, discussions, publications and correspondence that are

specifically directed at these users and which will generate feed-back from them. The information gathering, evaluation, and dissemination tasks that are called for by this process will be accomplished by NOAA.

Question. Clearly, the operational system cannot meet the detailed needs of all users. Some constraints are going to have to be imposed on the system or its cost will become prohibitive. How do you plan to do that?

Answer. Keeping costs down for operational remote sensing satellites is a function with which NOAA has become familiar in managing the operational environmental satellite program. Essentially there are two interrelated tasks.

a. A distinction must be made between desired capability and requirements. Existing or potential users must be able to state why certain performance is required, i.e., what benefits will be derived from a given improvement.

b. Once a requirement has been articulated in the user's own terminology, technical analysis must be performed to determine the most economical means for obtaining the required data. This involves trade-offs between various possibilities for space hardware as well as options for means of recovering the data and processing it. These trade-offs include the fundamental questions of whether particular data requirements can be more economically satisfied by other observation techniques such as aircraft overflights or in-situ observations.

Having determined that a requirement is fully justified and that its fulfillment by satellite remote sensing is advantageous, NOAA would then proceed to implement the necessary improvements, working through NASA for the technical verification or feasibility before finally committing to operational use.

The land remote sensing satellite program brings an additional motivation for cost reduction, namely this Administration's goal of eventual private sector operation of the system. As stated in the discussion document submitted by the Secretary of Commerce, private sector entry into the arena of land remote sensing hinges on the profitability of such an enterprise. Keeping costs down is an essential part of improving profitability.

Question. The transition plan shows that about 20 percent of renewable resource requirements need spatial resolutions better (finer) than 15 meters; 19 percent need better than 10 meters; and 10 percent need better than 2 meters.

What is the requirement for better than 15 meters spatial resolution?

What is the requirement for better than 2 meter spatial resolution?

Answer. No user stated a requirement for spatial resolution better than 2 meters. Table III-1 in the discussion document indicates that 90 percent of current preliminary requirements are met by a range of 2-30 meters which includes a panchromatic channel at 2 meter resolution. 10 percent of preliminary requirements can be fully met by resolutions in a range of 30-80 meters. In the renewable resource area, requirements for spatial resolution are interrelated with requirements for spectral resolution. As indicated by Table IV-2, high resolution panchromatic data are being considered as one hypothetical option.

Availability of finer spatial resolution data (2-30 meter resolution) would enhance the capability for the following:

Better delineation of crops in areas where agricultural activities are carried out in plots where one or both dimensions of the field is small, (e.g. European small fields, Asian terrace agriculture, areas of double—and inter-cropping where more than one crop is grown in the same field with small spatial separation, and farming in areas with peculiar dimensions such as along highway and power line rights-of-way);

Better quantification of forest devastation, whether accidental due to forest fire or intentional due to clear-cutting or so-called "slash-burning;"

More accurate preparation of so-called "sampling frames" in developing countries, which are used to understand better land use including agriculture in countries with small fields;

Monitoring of conservation activities including irrigation works; and

Early detection of pest and disease infestation onset.

Although the expected state-of-the-art would not permit very high resolution to be combined with multispectral sampling, the combination of 15 meter multispectral observation with 2 meter spatial resolution would also aid in crop classification, i.e., the determination of what is being grown in each field. This is because the higher spatial resolution aids in "registering" or precisely locating the multispectral data.

TRAINING

Question. Clearly, to expand the use of remote sensing data training programs must be set up. Currently, the EROS Data Center gives training to U.S. Government users and to some foreign users but refuses training for non-Government users. What are your views with respect to the managing entity of the Interim

Operational System and the Fully Operational System providing training to users regardless of whether the users are inside or outside the Government?

Answer. NOAA recognizes that training is one of the key mechanisms for expanding the market for land remote sensing satellite data. To this end, NOAA is considering ways of expanding current training programs such as those now conducted at the EROS Data Center. For example, NOAA could arrange through the private sector for general training on a reimbursable basis for Federal, state and local government personnel and for foreign students. NOAA also could assist university and private sector organizations in developing course materials to be used in training students from the private sector. Over time, other such mechanisms would be explored for increasing the training capability of the private sector as well as the number of persons exposed to such training.

We would hope that any private sector training programs initiated during NOAA's term as Interim System operator would be continued, in an appropriate format, once the system becomes fully operational.

SCHEDULE FOR OPERATIONAL SYSTEM

Question. What is meant by fully operational?

Answer. Fully operational means that the entire system can be designed from spacecraft and sensors through data processing and dissemination as an operational system in response to user requirements for data products and timely and reliable data delivery and taking into account the financial resources available for an operational system. This is in contrast to an operational system which is based on the specific configuration of the Landsat D series of satellites, including its MSS and TM sensors, and the associated ground system developed by NASA. While this system with the addition of any follow-on satellites and ground system improvements, would also be an operational system, it is called an "Interim Operational System" because it is based on a system designed in large part as an experimental system.

Question. What would be the frequency of coverage of the Fully Operational System?

Answer. The frequency of coverage has not yet been determined. The user community has indicated a range of frequencies required varying from about once every five-to-seven days to seasonal coverage. The frequency of coverage which will be recommended by the Administration will be dependent upon the capital and operating costs involved and the demonstrated existence of an adequate private and Federal market to justify such costs.

BUDGETING FEDERAL FUNDS

Question. What is your best estimate or recommendation of the annual Federal funds that will be required for both NASA and NOAA to carry out the Transition Plan recommendations. For example, what is needed in Fiscal year 1981, 1982, 1983, 1984, and so on?

Answer. The funding requirements for fiscal year 1981 are contained in the Administration's fiscal year 1981 budget request now pending before the Congress. $1.2 million has been requested for NOAA to enable it to fund a core staff of fourteen persons and to conduct $500K of contract studies. NASA's fiscal year 1981 budget request contains $94.3 million for continued construction and integration of Landsat D and D'

As discussed above, the annual costs of the Interim Operational System cannot be estimated until a specific configuration is recommended by the Administration as part of its fiscal year 1982 budget request.

Question. How do you propose that such funding be provided? What is your recommended funding option?

Answer. Until decisions are made on pricing policies, the scope of the Fully Operational System and the institutional framework for private sector ownership, we think it premature to propose methods for funding the ownership, we think it premature to propose methods for funding the Fully Operational System. For the Interim Operational System, based on the Landsat D series, Federally appropriated funds will provide a major source of system capital and operating costs, including the purchases of data by Federal agency users. Federal funding also will be required to initiate some advanced sensor development for the Fully Operational System. The Administration's recommendation for funding the required Interim Operational System improvements will be contained in the fiscal year 1982 budget submission. We anticipate that over time Federal funding will decrease as the private sector becomes more involved and assumes more financial risk.

Question. What activities would NOAA fund and carry out and what would NASA's funding responsibilities and program consist of?

Answer. As mentioned in the discussion document, NASA and NOAA have agreed to a phased transition of operational responsibility for the Landsat D program beginning in fiscal year 1983. Apportionment of funding should, therefore, reflect the following, agreed-to sequence of events:

Fiscal year 1983—Following launch, check-out and operational demonstration of Landsat D, NOAA would assume responsibility from NASA for spacecraft command and control and begin providing MSS data on an operational basis. (In a similar manner, NOAA would, at a later time, assume responsibility for MSS data from D').

Fiscal year 1984—NOAA will work with NASA to archive and disseminate TM data during the initial production phase from early 1984 until operational status is achieved. At that time, NOAA would begin providing TM data on an operational basis.

Along with these operational responsibilities, NOAA would also receive from NASA (i) ownership of the Landsat hardware, (ii) title to Landsat archival material at Goddard and (iii) space at Goddard to house the command and control, preprocessing, and, if cost-effective, archiving and dissemination functions for the Interim Program.

With respect to a market expansion program, NOAA proposes to assume responsibility for the conduct of joint demonstration projects with users while NASA's responsibility for development of new and advanced technology, satellite systems and prototype operational spacecraft would remain unchanged. In addition, NASA would continue testing of new techniques and potential new applications in joint projects with NOAA and users in the Federal, State and local governments and the private sector.

Question. How do you propose that Federal funds be budgeted and managed to make the Interim Operational System possible?

Answer. A decision has not yet been made on how Federal funds will be budgeted during the term of the Interim Operational System. The discussion document identifies three possible options for allocating the costs of the system among the budgets of NOAA and the user agencies. The options noted are:

(1) NOAA would budget all funds; i.e., NOAA would be responsible for seeking appropriations for that portion of the capital and operating costs of the "core" Interim and Fully Operational Systems not covered by revenues. In addition, NOAA would seek funds for any optional components beyond the "core" system required to meet special needs of users.

(2) As in (1), NOAA would be responsible for seeking appropriations for the "core" systems. However, costs attributable to any special system capabilities would be budgeted by the user agencies that want these capabilities.

(3) Rather than NOAA seeking appropriations, the major Federal user agencies would each seek appropriations for their proportionate share of both "core" and special system capabilities.

SYSTEM IMPLEMENTATION

Question. What in your judgment ought to be done to move forward as expeditiously as possible to implement the operational system as proposed in the Transition Plan? On what schedule should the Transition Plan be implemented?

Answer. The Administration should complete its review of the discussion document and develop its recommendation to the Congress with respect to the operational system and its implementation. This recommendation should be forwarded to the Congress as part of the Administration's proposed fiscal year 1982 budget and legislative program.

Question. What needs to be done now for fiscal year 1981 to move forward on the implemention of the Transition Plan?

Answer. Planning for the operational system should continue, leading to a more detailed definition of the user requirements to be met by the system and to more refined system alternatives for meeting these requirements. Initial decisions should be made with respect to the pricing of data and standard data products from the operational system and a market expansion program should be developed. The Program Board and the Land Remote Sensing Advisory Committee should be established. The Congress should consider and act upon the recommendations of the Administration with respect to the operational system, its management, and associated issues so that the operational land remote sensing satellite program can be implemented expeditiously in fiscal year 1982.

Question. If the Transition Plan is approved with its recommendations, what are the necessary steps that must be taken by the Administration with respect to:

Continuity of data?

Answer. The next major actions that need to be taken to implement the discussion document include the definition of "continuity" during the 1980's, both in space and on the ground. However continuity is defined, there is a strong likelihood that there will be a gap in data coverage between Landsat 3 and D. NASA is currently reviewing possible alternatives for launching D with a view to minimizing any gap that might materialize.

Depending on the definition of continuity, one or more additional satellites may have to be scheduled to follow Landsat D and D', so as to ensure coverage following the end of the useful life of Landsat D' and before the initiation of the Fully Operational System.

Improvements may need to be made to the MSS ground station to minimize the risk of losing some MSS data or having an excessively long delay in processing some MSS data. TM processing, although similar in nature to MSS, is substantially more complex. To deal with this and the additional volume of data that will be generated by the TM, additional ground facilities may be required. The Administration will make many of these decisions in developing its fiscal year 1982 budget request.

The fully operational system by 1989?

Answer. The discussion document considers four hypothetical Fully Operational System performance options. A determination must be made as to what Fully Operational System will be adopted and when it will be initiated. In addition, decisions will have to be made as to the following: the method of financing the system in the future; legislation establishing the institutional framework for the Fully Operational System; legislation enabling NOAA to own and manage the system until it is transferred to another entity; legislation establishing proprietary rights in the data and standard data products; and legislation establishing a regulatory framework for private ownership and operation of the system. The Administration plans to submit any necessary legislation as part of the 1981 Legislative Program.

Pricing and funding?

Answer. The discussion document identifies several areas of concern that should be carefully evaluated in the development of a pricing policy. Decisions will have to be made on each of these issues. The areas are: (i) consistence of pricing between foreign and domestic users; (ii) assistance to special users; and (iii) market development.

Within the context of the above, fees could be assessed for (i) data and standard data products, (ii) any reproduction or reuse of the product, and (iii) the direct reception of Landsat data by foreign ground stations. Prices could be increased at the outset of implementation of the operational system or phased in over time. There are advantages and disadvantages to each approach as set forth in the discussion document. A further study of pricing options will be made during fiscal year 1980 and fiscal year 1981.

Decisions will also have to be made, in the context of the fiscal year 1982 budget request, as to how the costs of the Interim System are funded. Similar decisions will have to be made for the Fully Operational System, but only after the underlying questions of institutional structure and the scope of the system are resolved.

Moving to the private sector?

Answer. The discussion document identifies and evaluates four institutional approaches for private sector ownership and operation. While possessing different strengths and weaknesses, each is responsive to the Administration's goal of transferring management of the system eventually to the private sector. A decision on the institutional framework for private sector ownership will require joint action of the President and the Congress.

Depending on the form taken by the Fully Operational System, there will likely be a gap between the revenues a private operator could expect to earn and the costs it would incur. To induce private sector investment, the Federal government may have to bridge the cost/revenue gap with capital or operating assistance.

No decisions with respect to the type of government support have been made at this time. The discussion document identifies various types of capital and operating assistance which could be provided, whichever institutional option is eventually chosen. Federal capital assistance could include Federal guarantees, appropriations, free services and tax incentives. The type of assistance chosen will, of course, have to be tailored to the institutional choice adopted for private sector operation.

Market expansion?

Answer. Since users will not be inclined to rely on land remote sensing satellite data unless its continuity is assured, it follows that assurance of continuity is a prerequisite to the increased use of such data. Further, unless substantial gaps in data coverage are prevented, foreign operators offering comparable data services will be in a position to obtain users of U.S. data products as customers. Thus, continuity is the first step in any market expansion program.

Within a setting of continuous data coverage, the goals of a market expansion program are twofold. First, the system must be tailored to user needs. NOAA's compilation of preliminary user requirements represents a significant step in this direction. NOAA will attempt to implement the results of its preliminary user survey by developing data products that are (i) designed to satisfy the requirements of as many users as possible and (ii) available over predictably long periods of time. In addition, market studies will be required to access further user requirements and to detect the emergence of new markets.

The second of NOAA's market expansion goals is that of helping users to benefit from the products of land remote satellite sensing. Such assistance should include training, applications development and applications demonstration.

To a substantial degree, these functions are already being performed by NASA and by Interior's EROS Data Center. NASA's applications development program likely will be continued as part of its ongoing R&D efforts. Additional activities which NOAA might sponsor could include work aimed at: assisting major Federal users in expanding their development of data applications; demonstrating the use of land remote sensing data in meeting Federal information requirements; exploring the use of government extension programs; and assisting AID in demonstrations to foreign users. In conducting these activities NOAA expects to involve the private sector, wherever practicable.

International issues?

Answer. Foreign users in nine countries now receive direct readout of Landsat data. Direct readout of Landsat data will generally be continued for data from the operational system. Expansion of the foreign user market (which now accounts for some 36 percent of Landsat revenues) is of key interest to the U.S. This is particularly so given the emergence of land remote sensing satellite programs in other countries and the potential for world-wide competition associated with such programs.

One of the Administration's goals is for the sharing of U.S. land remote satellite sensing costs among all users. To implement this goal, NOAA will investigate pricing policies for foreign users that, to the greatest extent possible, are consistent with prices charged U.S. users. NOAA will have to be aware of the pricing practices of foreign competitors and the possibility of lost markets through price undercutting.

With regard to foreign operators, NOAA will strive for complementarity of function wherever possible, consistent with the goal of U.S. technological leadership in the field of land remote sensing. To this end, NOAA has already conducted preliminary consultations with foreign operators and has helped to form a technical consultative group make up of program managers from those countries possessing or embarking upon land remote sensing satellite systems. The goals of this group (and of NOAA's related efforts in the area of complementarity) are three: (i) Maximize the potential usefullness of U.S. and foreign land remote sensing systems, (ii) minimize duplication and (iii) where possible, limit U.S. space segment costs.

DATA PRICING POLICY

Question. What is your view as to how prices for data and standard data products should be increased as we move from the experimental into the operational system and then the Fully Operational System?

Answer. NOAA can only determine precisely how prices for data and standard data products can be increased, as we move from the experimental into the operational system, after further analysis of the two options under consideration—(1) maximize revenues immediately or (2) phase in price increases gradually to promote the market. In either event, NOAA recognizes that price increases will be required in order to begin to recover, in part, the Federal government's costs of operating the operational system.

Question. How do you propose charging foreign ground stations for the right to acquire data directly from U.S. satellites?

Answer. NOAA proposes to continue the practice, established in the Landsat program, of charging foreign ground station operators for the right to acquire data directly from U.S. civil operational land remote sensing satellites. Among the types

of fees currently under consideration are: (1) an annual access fee like the $200,000 fee per station currently being paid by Landsat ground station operators and (2) a transmission fee paid by foreign ground station operators for data transmitted to and received by the stations, based on the amount of data requested. These fees will have to be negotiated with foreign ground station operators.

Question. What is your view with respect to having royalties paid by foreign ground stations to the U.S. managing entity for data collected from U.S. satellites and sold by that foreign ground station to users?

Answer. NOAA is examining the possibility of charging royalty fees both to U.S. and foreign users and foreign ground station operators on the reproduction or resale of land remote sensing satellite data products. Royalty fees are not charged at the present time.

Question. How would you insure that foreign ground stations don't under price the U.S. managing entity for data acquired from U.S. remote sensing satellites?

Answer. A determination on pricing controls, if any, to be applied to redistribution of data and data products by foreign ground stations also will be made over the next year as part of the ongoing process of implementing an operational program. If it is determined that it is necessary to control the pricing practices of foreign ground stations in order to preserve the market of the U.S. manager, the controls should be implemented through the terms of the Memoranda of Understanding negotiated for direct reception of satellite data. Among the factors to consider in determining whether to control prices charged by foreign ground stations are the anticipated market demand for such data, the impact on the revenues of the U.S. managing entity, the ability of the U.S. managing entity to recover costs by direct reception and other fees, the ability to enforce such policies and the U.S. policy of widest practical dissemination of land remote sensing data.

MANAGEMENT RESPONSIBILITY

Question. In the executive summary you say that during the interim operational phase based on Landsat D NOAA will manage the system in coordination with an interagency Program Board. What does manage the system in coordination with an interagency Board mean? Who will be responsible, NOAA, or the interagency Program Board?

Answer. In assigning to NOAA the responsibility to manage the civil operational land remote sensing satellite program, the President acknowledged the benefits to be derived from the designation of one lead agency to manage all national civil operational remote sensing satellite activities. To accomplish this objective, the system manager—NOAA—should have the authority and discretion to manage the operations of the satellite program, including the ability to manage the appropriated Federal funds cost users are willing to pay. Because of the continuing interest of and to establish a system which is responsive to user requirements at Federal user agencies in the land remote sensing satellite program, the President directed that an interagency Program Board will be established. This Board will serve as a mechanism for the coordination of the requirements of these user agencies and to assist NOAA in its management role by reviewing policy issues. It will also review private sector proposals and data and pricing policies.

COMPOSITION OF PROGRAM BOARD

Question. With respect to the Program Board, it is proposed that it be composed only of representatives of various government departments and agencies—yet that Board is to consider "private sector involvement"—why shouldn't representation from the private sector be apppointed to the Board?

Answer. Representation from the private sector is proposed for the Land Remote Sensing Satellite Advisory Committee (Committee) which the Commerce Department plans to establish in fiscal year 1981 as a Federal Advisory Committee to the Department on the land remote sensing satellite program. The Committee will consist of fifteen representatives selected by the Secretary of Commerce from the interested domestic non-Federal communities, including State, and local governments, end users, organizations that use Landsat data to supply information products, service organizations and potential commercial system developers and operators. The Chairman of the Committee will be asked to attend meetings of the Program Board, as necessary.

The Program Board, on the other hand, will consist of Assistant Secretary level representatives of interested Federal agencies. Among the Board's major roles will be review of Federal budget presentations and similar privileged Executive Branch documents. Appointment of private sector members, who are not full-time Federal

employees, to the Board would render the Board a Federal Advisory Committee, making consideration of such documents more difficult.

FEDERAL FUNDING ASSISTANCE

Question. The Transition Plan lists several options for Federal assistance. What is your recommendation for Federal assistance to reduce the expected gap between revenues and total annual costs that will be experienced by the operational system during the early years? How long would such Federal assistance be needed?

Answer. Federal assistance could be provided to the operator in a variety of ways. No recommendation or decisions with respect to the type of government support have been made at this time. However, it is assumed that Federal appropriations will continue to provide the major source of funding for the Interim Operational System.

The type, timing and volume of any assistance that is given for a private sector operator will necessarily depend on several variables. Among these are the institutional mechanism adopted for private sector operation, the ability of the private sector to raise revenue on its own and the projected size of the cost/revenue gap.

The Plan identifies a range of options for providing assistance. The options range from the Federal government providing some or all of the initial capital to agreeing to pay a guaranteed purchase price for the data and standard data products it uses.

Included under capital assistance options are the following:

Federal grants;

Federal guarantees of a minimum price for the sale of private operator stock; and

Federal loans or loan guarantees.

Included under operating assistance options are:

Federal agreements to purchase data products at prices that would cover virtually all costs of operation;

Overall price assistance based on an evaluation of the corporation's operations;

Appropriation of funds to assure cost recovery or the provision of free services; and

Tax incentives (where, for example, the operator has taxable income from other operations).

LEGISLATION

Question. When do you propose to submit legislation providing authority to NOAA to establish and operate a remote sensing system?

What would be the content or substance of such legislation?

Answer. On March 26, 1980, the Secretary of Commerce submitted to Congress a bill that would authorize NOAA to establish and operate a land remote sensing system from space. Enactment of this bill (as modified in H.R. 7098, S. 1391) would provide NOAA the authority needed to establish the operational system.

The Administration plans to introduce legislation in the 97th Congress. Likely areas for additional legislation include establishing proprietary rights in land remote sensing data and data products, establishing the institutional framework and appropriate Federal financial assistance for eventual private sector ownership and operation, providing NOAA the authority to develop, own and operate the U.S. civil operational land remote sensing system until the responsibility is transferred to another entity, and authorizing NOAA to regulate the activities of, and to coordinate Federal user relations with, any private sector operator. The exact content of any additional legislation will be developed by the Administration as part of its legislative program for 1981.

Question. Would such a legislative proposal provide for the transfer of the operational remote sensing system to the private sector? If not, why not?

If so, would such a transfer be stated as a firm objective of the program?

Answer. The Administration's goal is for the eventual transfer of civil operational land remote sensing satellite activities to the private sector. Any bill submitted by the Administration will state this goal as an objective of the program. The timing of the transfer to private sector ownership and operation and the appropriate institutional framework are still being examined by the Administration.

[The following information was subsequently received for the record:]

Questions of Senator Heflin and the Answers Thereto

IMPLEMENTATION OF THE PLAN

Question. What are the next major actions that need to be taken to implement the transition from the current experimental land remote sensing satellites to the interim operational system and then to the fully operational system?

Answer. The next major actions that need to be taken to implement the President's decision include the definition of "continuity" during the 1980's, both in space and on the ground; a determination of when a fully operational system will be initiated and its technical characteristics; the method of financing the system, both initially and in the future; the institutional framework for the fully operational system; the scale of any market expansion program during the 1980's; legislation enabling NOAA to own and manage the system until it is transferred to another entity; establishment of the Program Board and the Land Remote Sensing User Advisory Committee; establishment of pricing policies for the 1980's; legislation establishing proprietary rights in the data and standard data products; legislation establishing a regulatory framework for private ownership and operation of the system; negotiation of agreements with countries wishing to receive data during the 1980's; and continuation of complementary discussions with other countries planning operational land remote sensing satellite systems.

Question. Are additional studies required before you can proceed to implement the interim operational system?

Answer. Additional technical studies are not required before we can proceed to implement the interim operational system. However, NASA is in the process of evaluating progress with respect to the construction and integration of both Landsat D and D'. The results of its evaluation will be available in the July/August time frame.

NOAA plans to conduct pricing and market expansion studies in fiscal year 1981–1982. These will not affect implementation of the interim operational system, but will affect achievement of the President's goal of eventual private sector ownership and operation of the system.

Question. What additional studies must be undertaken and completed before you are ready to proceed with the implementation of the fully operational system?

Answer. NOAA must conduct mission needs definition studies and system definition studies in order to proceed with detailed system design for the fully operational system, and may have to conduct studies of the various private sector options. In addition, NASA must conduct the R&D studies necessary to develop the new solid state sensor technology for the fully operational system.

Question. Has the Government estimated its remote sensing data requirement for the future?

Answer. The Federal user agencies have provided tentative estimates of their remote sensing satellites data requirements for late 1980's. The process of collecting and assessing their requirements is by no means complete, however. Estimates of usage will change as new techniques for using the data are developed and existing techniques are improved. The initial assessment was not tied to any information about prospective costs of standard data products, which will be a key determinant of actual user demand. In addition, no assessment has been made of the number of standard data products that could be sold as a function of price. Such a market survey would not yield meaningful results until the options for a Fully Operational System are clearly defined and a range of probable prices for particular types of data can be offered for evaluation by user agencies.

Assessment of user requirements must, therefore be a continuing, interactive process involving the evaluation of needs and relative benefits as a function of system performance and cost. Mechanisms for achieving this ongoing evaluation will be available to Federal user agencies through the Program Board described in Chapter II of the Issues and Options document.

Question. Is there a market projection that indicates that private sector ownership and operation of an operational land remote sensing system is possible?

Answer. No. Reliable projections of revenues from sales of standard data products, and from the direct reception fees to be paid by foreign ground station operators, cannot be made at this time since the characteristics of the Interim and Fully Operational Systems, the users' level of demand at various prices, the impact of a market expansion program and the impact of foreign competition are not now known. Tentative projections indicate that this system may not and probably will not be self-financing before the end of the century. Therefore, continued Federal financial contributions to support of the system likely will be necessary for the foreseeable future.

Question. Assuming private sector ownership of an operational land remote sensing system, what sort of government support is envisioned?

Answer. No decisions with respect to the type of government support have been made at this time. The Issues and Options document identifies various types of capital and operating assistance which could be provided, whichever institutional option is eventually chosen. Federal capital assistance could include grants, equity guarantees, and Federal loans and loan guarantees. Federal operating assistance could include Federal support of research and development, purchase guarantees, appropriations, free services and tax incentives.

Question. What consideration has been given to possible private sector involvement in market expansion for the use of satellite remotely sensed data?

Answer. NOAA proposes to contract with the private sector to the maximum extent possible in the implementation of any market expansion activities for the use of satellite remotely sensed data. In addition, if a private entity is selected or created to own and operate the fully operational system, NOAA plans to transfer responsibility for market expansion activities to that entity at the earliest possible moment.

Question. It appears that additional or new types of satellites will have to be procurred to implement the fully operational system. How soon must procurement activities get under way if there is to be no gap in the continuity of data?

Answer. Initial NASA funding for the research and development necessary for the new solid state multi-linear array sensors should be provided in fiscal year 1982 if the system is to become fully operational in 1989. Initial NOAA funding for the mission needs and system design studies for the fully operational system should also be provided in fiscal year 1982.

NOAA ORGANIZATION

Question. What sort of organizational changes do you envision or have been made in NOAA in order to implement Presidential Directive 54?

Answer. The Department of Commerce is proposing the elevation of the National Environmental Satellite Service (NESS) which is responsible for NOAA's satellite programs from a major program element (MPE) within one of its four major line components (MLC) to a new MLC reporting directly to the Administrator of NOAA. NESS would be renamed the National Earth Satellite Service to reflect its new land and ocean satellite missions. Within NESS, small policy, user relations and international affairs staff offices would be established to handle the complex issues presented by these new missions. In addition, NESS's existing technical staff would be augmented as appropriate.

Question. What changes in NOAA's organization have to be made to proceed with the interim operational system? To proceed with the fully operational system?

Answer. The proposed organizational changes set forth above will enable NOAA to proceed with the interim operational system. If a decision is made to transfer the fully operational system to a private entity, NOAA will be required to establish an appropriate regulatory staff. In addition, it will at that time reduce its technical staff.

Question. What provisions are you making for augmenting the NOAA staff to undertake these new responsibilities?

Answer. NOAA's fiscal year 1980 budget supplemental request contains funding for fourteen new positions to establish the core staff offices described above and to augment NESS's existing technical staff. As decisions are made on the direction of the land remote sensing program, additional staff may prove to be necessary.

FUNDING

Question. Have funding requirements for the early years of NOAA activity on operational land remote sensing been identified? What are the funding requirements for fiscal year 1981 and fiscal year 1982? Do these requirements include both the needed NOAA funds and the needed NASA funds? How are these requirements being met?

Answer. NOAA estimates that the annual costs of the interim operational system over the next seven fiscal years will average $150 million a year in fiscal year 1980 dollars for a total of $1,050 million. The funding requirements for the fully operational system depend upon the complexity of the system selected for implementation, with costs ranging from $1 billion to $10 billion in fiscal year 1980 dollars over the projected ten-year life of the system. For example, a continuation of the Landsat D Series with solid state sensors would cost $2 billion in fiscal year 1980 dollars. The addition of a 15 to 20 meter resolution channel could raise costs to $2.5 billion.

The funding requirements for fiscal year 1981 are contained in the Administration's fiscal year 1981 budget request now pending before the Congress. $1.2 million has been requested for NOAA to enable it to fund a core staff of fourteen persons and to conduct $500K of contract studies. NASA's fiscal year 1981 budget request contains $94.3 million for continued construction and integration of Landsats D and D'. The fiscal year 1982 budget requirements of both NOAA and NASA are under review within the Administration and will be submitted as part of the President's fiscal year 1982 budget.

Senator STEVENSON. Thank you, Mr. Frank. I apologize to you and everyone for being late this morning.

I think, if there is no objection, we will follow through with the rest of the testimony, and then come back to all of you with questions.

Dr. Frosch, would it be possible for you to summarize your statement?

Dr. FROSCH. Thank you, Mr. Chairman.

I am pleased to be here today to discuss administration planning activities directed toward establishing a civil operational land remote sensing satellite system. NASA has provided a system to NOAA over the past 6 months in the preparation of the plan which we believe provides a workable outline for the transition period, while maintaining flexibility. We are particularly pleased at the existing relationship between NASA and NOAA which has worked so effectively in the past for meteorological satellites, and which we expect to continue to work effectively for the new ocean satellites, NOSS.

Before commenting on the planning efforts, let me speak to NASA's immediate concern, which is the interim operational system. This is to provide continuity of data through the 1980's through use of Landsats. While Landsat-2 has far exceeded its estimated lifetime, degradation is occurring in both Landsat-2 and Landsat-3, thus raising the possibility of a data gap before the launch of Landsat-D.

In November 1979, we lost control of Landsat-2 due to the freezing of its yaw momentum wheel and were no longer able to control the pointing accuracy required for the collection of data. By May of this year, we were able to recover use of the momentum wheel, but by this time the cold gas normally required for the spacecraft attitude control system was exhausted. We then experimented with magnetic moment compensation procedures and found that, indeed, the spacecraft could be controlled with these procedures, and that it was possible to collect multispectral scanner (MSS) data. We then experienced a tape recorder failure which now restricts the use of Landsat-2 to direct readout only. I would like to interject at this point that of course these failures of the system have occurred long past the period which was designated as its nominal engineering lifetime, and we are living in an extended period.

We also have had tape recorder difficulties of a different nature on Landsat-3 which restricts its use to the one remaining tape recorder for recording MSS data.

The remaining capabilities of the two spacecraft have allowed us to devise a tentative plan which will permit 18-day coverage over the United States for MSS data collection with Landsat-2, and normal coverage from the return beam vidicon (RBV) camera aboard Landsat-3. Landsat-3 is being used to record limited MSS data over areas outside the United States, so Landsat-2 is prime for

domestic coverage, and Landsat-3 is prime for foreign coverage. When we have gained sufficient confidence in this mode of operation, it may be possible to use both spacecraft over the United States for collection of MSS data to provide 9-day interval coverage.

As we have reported to the Congress, we have had the Landsat-D program under review since last January when technical problems and the resulting schedule and cost impacts forced us to reevaluate the baseline program. Since then, we have engaged in an intensive series of reviews with the involved contractors and within NASA to determine the most realistic cost and schedule estimates required to get the program back on the right track.

These reviews have addressed a series of programmatic modifications which have been narrowed to three options:

One, the baseline program, with launch of the thematic mapper (TM) and the multispectral scanner on both Landsat-D and Landsat-D′;

Two, termination of the thematic mapper, with launch of the MSS only on D and D′; and

Three, the earliest possible launch of Lansat-D with the MSS only, to be followed by Landsat-D′ with both the TM and MSS.

We will not be in a position to make a final decision on these options until we complete our detailed analyses this summer. However, results to date have led us to focus on the third option listed above. It should be noted that, should subsequent contractor progress warrant this option would not exclude the possibility of flying the TM on Landsat-D. Accordingly, we are planning actions necessary to implement that option, recognizing that we may ultimately select either of the others depending on the results of our completed analyses which will include cost proposals from the principal contractors.

The Landsat-D system will serve as a basis for an interim operational land remote sensing satellite system under NOAA's direction. The following projected transfers of operational responsibility would allow NOAA to operate the Landsat-D system.

One, in fiscal year 1983, following launch, checkout, and operational demonstration of Landsat-D, NOAA would assume responsibility from NASA for spacecraft command and control and begin providing MSS data on an operational basis. Similarly, NOAA would assume responsibility for MSS data following launch of the Landsat-D′ spacecraft. After a NASA test and demonstration period, NOAA would assume responsibility for TM data if and when that system reaches operational status. NASA would transfer ownership of Landsat-D hardware, along with the operational responsibility.

Two, NOAA would also assume responsibility for that portion of the generation and dissemination of data and standard data products performed by NASA.

Three, NASA would transfer title to Landsat archival material at the Goddard Space Flight Center to NOAA.

Four, NASA would work with NOAA to identify space at the Goddard Space Flight Center which could be used to house the command and control, preprocessing, archiving and dissemination functions for the interim program.

NASA's responsibilities for development of new and advanced technology, satellite systems, and prototype operational spacecraft would remain unchanged. NASA would, where appropriate, continue to develop and share with users technologies for acquiring, processing, and interpreting land remote sensing satellite data. In addition, NASA would continue testing of new techniques and potential new applications in joint projects with NOAA and users in the Federal, State, and local governments and the private sector. Careful attention would be paid to assuring that NASA R. & D. efforts do not duplicate those of the private sector. As part of these efforts, NASA would undertake the development of a broad array of information extraction procedures aimed at specific application through our technology transfer program.

NASA has enjoyed great success in its technology transfer projects generally, and particularly in regard to encouraging the use of remote sensing satellite data by both the public and private sectors. Our applications systems verification and transfer and application pilot test programs consist of over 20 large scale feasibility projects which serve as detailed prototypes for large user markets. NASA's three regional remote sensing application centers have trained more than 1,500 State agency personnel, and approximately 30 states have instituted projects based on Landsat data. In addition, over 25 university programs in remote sensing have been established as a result of our university applications program.

As I stated earlier, Mr. Chairman, I believe the transition planning has produced a workable course of action. It is similar in many respects to the agreement under which NASA and NOAA work together in the meteorological satellite program, where basically NASA performs the systems research and development and serves as NOAA's procurement agent, and NOAA directs the operational system.

NASA and the Department of Commerce have worked together successfully for nearly two decades in providing the Nation and the world outstanding meteorological services. We have accomplished this working under only an eight-page agreement—the main ingredient to our success has been a spirit of cooperation to serve a national purpose. I see no reason why we should not be equally successful in bringing forth the civil operational land remote sensing satellite system.

Thank you, Mr. Chairman. I will be happy to answer any questions which you may have now, or at your pleasure.

[The following information was subsequently received for the record:]

QUESTIONS OF THE COMMMITTEE AND THE ANSWERS THERETO

Question. Will you please describe for the Committee each of the Landsat-D and -D' options under consideration and the launch schedules associated with each option?

Answer. Options under consideration for Landsat-D and -D' are the following:

Launch of Landsat-D with the MSS only in July 1982, with Landsat-D', equipped with both the MSS and TM, available for launch in July 1983.

Launch of Landsat-D with the MSS only as soon as possible, but probably not before February 1982, and Landsat-D', equipped with only the MSS, available for launch in December 1982.

Launch of Landsat-D with both the MSS and TM as early as possible, but probably not before September 1982, and Landsat-D', with both the MSS and TM, available for launch approximately June 1983.

The above dates are approximate, and presuppose the successful conclusion of negotiations between the U.S. Government and the General Electric Company and Hughes Aircraft Company.

Question. Are there problems with the integration of Landsat-D spacecraft and is that affecting the launch schedule?

Answer. The major integration actions for Landsat-D will occur during the integration of the instrument module, i.e., the MSS (and TM, if applicable) with the spacecraft, and of the communications module with the spacecraft. These actions have not yet begun. If significant difficulties are encountered during these integration activities, there will probably be an impact on the planned launch schedule.

Question. What effect are funding limitations having on whether or not the Thematic Mapper is flown on Landsat-D?

Answer. The primary considerations in determining whether the TM should be flown on Landsat are (a) minimizing the potential gap in data acquisition capability and (b) the progress in development, fabrication, and testing of the TM for timely delivery to General Electric. Applying more funds or manpower beyond that already requested would probably not appreciably affect either of these two considerations.

Question. In selecting the Landsat-D option, how will cost be traded off against providing appropriate data and continuity of data to the user?

Answer. In selecting the option, the difference in costs between options will be correlated with the differences in service to users, e.g., the value of TM data for the affected growing seasons, and the differences projected in achievable launch and checkout schedules. For example, if the cost difference between two of the options was small and the difference in sensor capability was large, then the latter influence would drive the decision. Where margins in capability and cost are similar, then other considerations such as confidence in schedule, confidence in achieving an interim operational capability, and programmatic complexity start to have relatively larger influences than they would otherwise have on the decision. All influences, of which cost is only one, will be considered in each of the three options.

Question. When will the procurement of additional Landsat-D's have to be initiated if there is to be no gap in providing data and standard data products during the period served by the interim system?

Answer. Assuming dual spacecraft operation (-D and -D'), the procurement of additional Landsat-D spacecraft and associated instruments will have to be initiated in fiscal year 1982 if there is to be no gap in providing data to the users.

Question. To carry out the recommendations of the Transition Plan, there will have to be an aggressive research and development effort, and it is recommended that this R&D be done by NASA.

a. In your view, what research and development projects need to be initiated or continued in fiscal year 1981 to accomplish what is recommended by the Transition. Plan?

b. On what schedule can these R&D projects be carried out?

c. Can you give us an estimate of the annual funding requirements to do this research and development?

Answer:

a. The highest priority is the continuation of the development of Landsat-D and -D', including the Thematic Mapper, and the associated ground processing system. In fiscal year 1981, the definition study for the Operational Land Observing System (OLOS), including the user requirements, must be continued.

The extension of the technology required to develop sensors needed to meet the user requirements in the operational ear must be pursued. The developments implicit in the NOAA Transition Plan include: MLA solid state sensor, panchromatic stereo capability (15m resolution), panchromatic high resolution (2m) imagery, multifrequency imaging radar, and passive microwave imager.

In addition, research must be continued on how to derive the maximum information from the higher resolution data and additional spectral bands available with the Thematic Mapper. A strong research program has also been initiated on how to use synthetic aperture radar data, particularly with regard to geological mapping and non-renewable resource exploration.

b. Development schedule for Landsat-D and -D' and the associated ground processing system is currently under review. The definition study of the OLOS was initiated in fiscal year 1980 and will continue through fiscal year 1981.

A fiscal year 1982 Advanced Technology Development effort is under consideration for the MLA Solid State Sensor with a possible fiscal year 1983 new start for sensor development. The sensor could fly on an R&D demonstration mission in early 1987 and on the OLOS in 1989.

Panchromatic stereo capability will be considered for the MLA Solid State Sensor as part of the sensor definition studies in fiscal year 1981. Capability for worldwide stereo coverage could then be possible on the OLOS in the early 1990's.

Feasibility studies for a High Resolution Panchromatic Imager should be performed in fiscal year 1982. An fiscal year 1987 new start is under consideration with launch in fiscal year 1993.

A fiscal year 1984 new start is being considered for the Multifrequency Imaging Radar with flight on an R&D mission in late fiscal year 1988.

A Passive Microwave Imager is planned for the Soil Moisture Research and Assessment Mission in fiscal year 1980; a new start would be required in fiscal year 1986.

c. $1.8M has been budgeted in fiscal year 1981 to continue the definition study for the OLOS.

Development of the MLA Solid State Sensor is presently estimated to cost $150-175M excluding the $10M required for Advanced Technology Development with first year funding of approximately $15M and total funding spread over 5-6 years. Current plans would require first year funding in fiscal year 1983.

Addition of panchromatic stereo capability to the MLA Solid State Sensor is estimated at $25-35M spread over the fiscal year 1983-1986 time frame.

A High Resolution Imager capable of providing panchromatic images at 2m resolution is estimated to cost $325-375M spread over the fiscal year 1987-1993 period.

Cost of a Multifrequency Imaging Radar Sensor is estimated to be $150-175M with first year funding of approximately $15M and total funding spread over 5-6 years. Current plans would require first year funding in fiscal year 1984.

Our preliminary estimate is that approximately $50M would be required to develop a Passive Microwave Imager and the antenna required for soil moisture measurement.

Senator STEVENSON. Thank you, Dr. Frosch.

Mr. Johnson, we have a very useful and detailed statement by you. I think we could expedite things if we just put it in the record and then ask all of you questions.

So if there is no objection, that is what we will do. Thank you.

[The statement follows:]

STATEMENT OF DAVID S. JOHNSON, DIRECTOR, NATIONAL ENVIRONMENTAL SATELLITE SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, DEPARTMENT OF COMMERCE

Mr. Chairman and Members of the Committee, I am pleased to appear before you today to discuss the various options which the Satellite Task Force considered for moving from the current, largely experimental land remote sensing satellite system toward an operational system. My oral testimony will highlight some of the key technological, organizational, cost and international aspects of the Administration's planning for an operational land remote sensing satellite system, all of which are discussed in greater detail in the document entitled "Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options" submitted to you by the Secretary of Commerce.

Most of these issues and options are under review by the Administration as part of the development of its fiscal year 1982 budget and legislative programs. The views of the members of this Committee on the various options are desired by the Administration as it develops its recommendations in the following months on proceeding with the operational system.

The Satellite Task Force has considered two phases of the operational system: An Interim Operational System and a Fully Operational System. As Mr. Frank has indicated, we do not expect to achieve the high quality operational performance standards set forth in the discussion document before a Fully Operational System is implemented and even then such standards must be carefully weighed against their full costs, the benefits to public and private users, and the willingness of private users to absorb their full share of the costs. Within each phase, technological, organizational and cost issues arise which must be resolved if the goal of an operational system with eventual private sector ownership and operation is to be achieved.

1. THE INTERIM OPERATIONAL SYSTEM

When the President assigned NOAA in November 1979, management responsibility for the U.S. civil operational land remote sensing satellite activities, NASA was

operating its largely experimental Landsat system. Dr. Frosch's testimony describes the current status of Landsats 2, 3 and the new Landsat D satellites.

Because of the advanced state of development of NASA's Landsat D satellite series and the considerable time and cost involved in designing and developing a completely new system with advanced sensor technology that is responsive to a broad range of user requirements, the initial decision already has been made that NOAA will take over the Landsat D system and operate it as the basis of an Interim Operational System until an eventual Fully Operational System can be developed.

NOAA and NASA are working closely together to assure a smooth transition from the Landsat D experimental phase to the Interim Operational System as the first step in meeting the Administration's commitment to continuity of land remote sensing data during the 1980s.

a. Continuity of spacecraft coverage

Initially our objective as manager of the operational system is to assure continuity of data in the 1980s. To accomplish this objective, NOAA is participating with NASA in the review of the launch schedule of Landsat D and D', in light of the potential gap in coverage between the demise of Landsat 3 and the launch of Landsat D. One or more additional satellites may be desirable after D' to allow simultaneous early dual spacecraft coverage without a significant break until the Fully Operational System is established, although the costs and benefits of this approach require further study.

b. A reliable ground system

The present ground system at Goddard for preprocessing data from the Landsat D series of satellites is also under review to see where improvements may be desirable. If necessary, improvements to the MSS ground system may have to be made to reduce the risk of losing significant amounts of data or having an excessively long delay in processing the data. Equipment could be added to increase reliability and to provide for priority processing of some data.

Since the TM would be a new, untried sensor, new techniques are being developed for preprocessing TM data. Initiation of some additional improvements in the ground system after the experimental phase of TM could help to move the Interim Operational System towards desired operational performance standards, including processing that is responsive to user requirements for timeliness and data processing priorities. However, the TM is a research instrument and its utility in an operational system remains to be proved.

c. Management responsibilities

NOAA proposes to assume responsibility from NASA for operation, control and dissemination of data from the Landsat D system as the Landsat D and D' satellites and the respective ground systems for preprocessing MSS and TM data meet initial performance requirements. A smooth transition can be accomplished by NOAA's colocating personnel at the Goddard Space Flight Center and taking over the NASA support contracts.

As part of the transition to an operational system, NOAA also plans to assume responsibility for the functions now being performed at the Department of the Interior's EROS Data Center of the archiving and dissemination of land remote sensing satellite data and standard data products at approximately the same time NOAA assumes control of the Landsat D satellites and production of data. If it is cost-effective, a distribution center for data and standard data products—similar to the presently produced computer compatible tapes and images—could be colocated with the Landsat D preprocessing facility at Goddard Space Flight Center. NOAA's Environmental Data and Information Service would be responsible for archiving the data and servicing retrospective users. The EROS Data Center would then constitute the primary focus within Interior for Landsat data and would continue to perform its many other functions such as the archiving and dissemination of Interior's aircraft data, serving users who draw upon this archive, as well as research related to Landsat application of interest to Interior and the conduct of training programs in the use of Landsat data for Interior personnel.

d. Program board and land remote sensing satellite advisory committee

NOAA will be assisted in this new program by an interagency Program Board at the Assistant Secretary level, which the Commerce Department proposes to establish in fiscal year 1981 for continuing Federal coordination and to consider issues related to regulation and private sector involvement. In addition, we plan to estab-

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lish a Land Remote Sensing Satellite Advisory Committee consisting of fifteen representatives from the interested domestic non-Federal communities, including State and local governments, end users, organizations that use Landsat data to generate information products, service organizations and potential commercial system developers and operators.

2. THE FULLY OPERATIONAL SYSTEM

The principal distinction we have made between a Fully Operational System and the interim system is that the Fully Operational System should be designed to generate cost effective data responsive (and ultimately, in a self financing manner) to a broad range of user requirements.

a. Survey of user requirements

As part of its planning efforts, NOAA has conducted a preliminary survey of requirements of users in the governmental and private sector communities both in the United States and abroad. This survey revealed a wide range of user specifications for spectral bands, spatial resolution, area coverage, revisit frequency, timeliness and data volume depending on the application. We must sort, prioritize and validate these myriad requirements as decisions are made regarding the design of a Fully Operational System which meets a maximum of user specifications for data consistent with a cost users are willing to pay. The benefits to be derived from a system which is responsive to user requirements and competes effectively for the domestic and foreign user market must be weighed against the higher costs and methods of financing a technologically advanced and fully responsive system.

b. Hypothetical performance options

Since the design, development and launch of a satellite with new solid state multi-linear array sensors takes several years, the Satellite Task Force examined some very tentative hypothetical performance options for a Fully Operational System which could be implemented in 1989, at the earliest. The 1989 date reflects only the development time required and federal budgeting and procurement processes. The transition to private ownership of our civil operational land remote sensing satellite activities could, of course, influence the final design and cost of the Fully Operational System.

The hypothetical system options have been identified as:

(1) Extension of the Landsat D series; (2) A "Minimum System"; (3) A "Middle System"; and (4) A "Maximum System". These hypothetical systems differ in levels of resolution, spectral bands and frequency of coverage; however, all of them would use more reliable, longer life solid state multi-linear array sensors rather than the mechanical scanners being used on the Landsat D series of satellites:

Following is an outline of the hypothetical systems, their principal characteristics and estimated costs:

(1) The extended Landsat D series would involve two operating satellites, and the equivalent of the 80 meter resolution MSS bands and 30 meter resolution TM bands and could provide occasional 8-day revisit coverage would be the norm. Improvements to the present Landsat D system could focus on the introduction of solid state multi-linear array sensors and increased satellite life to improve reliability and reduce costs. The estimated 10-year capital and operating costs of this system are $2.0 billion in fiscal year 1980 dollars.

(2) The "Minimum System" generally could provide 80 meter resolution, possibly with some observations in a single band at 40 meter resolution, and occasional 8 or 9 day revisit coverage as required. The estimated 10-year cost of the Minimum System is $1.0–$1.5 billion.

(3) The "Middle System" is characterized by observations from a single band at 15 or 20 meter resolution in addition to 30 or 40 and 60 or 80 meter resolution using all of the bands now projected for coverage by TM. Eight or nine day revisit frequency could be provided as well as steerable sensors to avoid cloud cover. The estimated 10-year cost of the Middle System is $1.5–$2.5 billion.

(4) The "Maximum System" is characterized by limited area coverage at 10 and 20 meter resolution from bands projected for coverage by TM in addition to data at 30 or 40, and 60 or 80 meter resolution. The estimated 10-year cost of the Maximum System is $3.0–$5.0 billion. Providing 2 meter resolution to meet the stated requirements of some users would increase the costs of the Maximum System by $4 to $5 billion. Allowing much greater resolution than the 30 meter resolution of the Landsat D series also involves international and national policy considerations.

Additional funds of between $200 and $700 million would be required to produce global sets of steroscopic coverage which is of particular interest to the mineral extraction industry.

An initial evaluation of these hypothetical system designs indicates that the Minimum System may not meet the currently stated needs of the majority of users and would have lower performance characteristics than the Landsat Thematic Mapper. The upgraded Landsat D system and the optimum Middle System are relatively similar in cost and performance; inclusion of a 15 meter resolution in one band on either of these systems could be desirable and would place the U.S. at least on a par with the prospective operational French and Japanese systems, which I will come back to later. The Maximum System meets virtually all stated user needs but at a cost that users will probably not be willing to pay. At this point, the additional value of the refinements offered by this system is speculative.

Firm decisions on system specifications require further analysis of user requirements, the maximal cost of various additional capabilities, the establishment of budget priorities and the mechanisms for system financing.

3. FINANCING THE OPERATIONAL SYSTEM

While a decision is pending on the form and timing of eventual private sector ownership, some initial funding for the design and development of key elements of the Fully Operational System may be required.

For the first time in the U.S. civil remote sensing satellite program, we are beginning to look at ways to recover the costs to the Federal government of financing an operational land remote sensing satellite system. Federal success in generating revenues from sales of data and standard data products and from access fees paid by foreign ground station operators may serve as an incentive to prospective private sector owners and investors in the operational system. However, due to the large gap projected between present system revenues of approximately $6 million a year in fiscal year 1980 dollars and the projected costs of the operational system, even estimated increased revenues from sales and access fees likely will have to be supplemented by some form of Federal financial assistance for the foreseeable future.

a. Pricing policies

Some issues that have to be addressed in recovering the cost of the operational system are how to price the data and products during the Interim Operational System and how to budget the Federal government's costs. With respect to pricing policies, two options relating to price increases were examined by the Satellite Task Force for consideration by the Administration. These alternatives are (1) increasing prices so as to maximize revenues immediately and (2) gradually phasing in price increases in order to promote development of an expanded market for land remote sensing data and standard data products. A decision will be made that balances, on the one hand, the prospective advantage of recovering the greatest amount of system costs with an eye to encouraging the private sector to invest and, on the other hand, the concern that users may be driven out of the market with this approach. With a phasing-in of price increases, prospective users should realize that prices would escalate towards the full cost of the services provided.

A second aspect of pricing which the Task Force examined was the type of fees that could be charged for data sold to domestic and foreign users and to foreign ground station operators. We have identified three types of possible fees:

A Basic Fee that would be paid by each user on each standard data product purchased from the U.S. system operator;

A Royalty Fee that would be paid by each U.S. and foreign user and foreign ground station operator on the reproduction or resale of standard data products; and

A Direct Reception Fee that would be paid by foreign ground station operators receiving data directly from U.S. land remote sensing satellites, including an annual access fee and a transmission fee for data transmitted to and received by the foreign ground stations.

Implicit in the proposed pricing policies and fee structure is the treatment of land remote sensing data and standard data products as valuable property owned by the system operator and sold to users at prices that reflect, in part, the total cost of producing these products. In our view, legislation would be needed to create these property interests.

During 1980 and 1981, NOAA will conduct studies of pricing alternatives and develop fee proposals for consideration by the Program Board and the Land Remote Sensing Satellite Advisory Committee.

4. INTERNATIONAL COOPERATION

Since the beginning of the Landsat program, international participation in the U.S. land remote sensing satellite system has been significant. NOAA plans to continue to involve foreign countries in the operational system both as users of the data and as cooperative participants in an international network of national systems.

a. Direct readout to foreign ground stations

NOAA proposes to continue the present practice of generally supporting direct readout of data from the operational system to foreign ground stations. NOAA would develop memoranda of understanding containing new pricing arangement for those countries now receiving data directly from Landsat who want to receive data directly from the operational systems. These pricing arrangements would be developed so that prices are consistent for domestic and foreign users. Notice of price increases would be provided to foreign countries in time for them to arrange for necessary funding.

b. Cooperation with foreign satellite operators

The present plans of some foreign countries to develop their own operational land remote sensing satellite capabilities offer, as Mr. Frank has said, the prospect of both competition and cooperation with the U.S program. France, Japan, Germany and others are developing multi-linear array detectors for land remote sensing from space. The French SPOT land remote sensing satellite system is under construction and is scheduled for launch in 1984. The Japanese plan to fly multi-linear array sensors on an ocean observations mission in 1985 and on a land observations satellite in 1987. The European Space Agency is considering plans to launch an ocean monitoring satellite in 1986 and a land applications satellite system in late 1987 or early 1988. The earliest that new U.S. multi-linear array sensor could be available for test flight in FY 1986 and for routine operational use is 1989. Data from these foreign programs could penetrate the market for data and data products if they are of superior quality and less costly than those available from U.S. systems. As U.S. plans evolve for the Fully Operational System, the potential impact of foreign competition must be one consideration.

In the meantime, recognizing the beneficial aspects of foreign satellite plans, we have initiated discussions with prospective foreign satellite operators to explore complementarity and compatibility among the planned national satellite systems. We have already participated in a meeting in Ottawa in May 1980, with Canada, the European Space Agency, France, India and Japan. As a result of this meeting, an informal, technical group of prospective land remote sensing satellite program managers is being created to examine possible complementarity and compatibility. The Centre Nationale d'Etudes Spatialies of France has agreed to convene the first meeting later this year.

In addition, we plan to participate in informal regional meetings of satellite operators and potential users in Latin America, Africa and Southeast Asia in an effort to expand the worldwide use of land remote sensing data. Lastly, NOAA intends to continue the NASA-established Ground Station Operators Working Group which consists of those foreign agencies operating or planning to operate Landsat ground stations and which provides a useful forum for the exahange of technical information and experience.

This concludes my review of the key technological, organizational, cost and international aspects involved in developing the civil operational land remote sensing satellite system. We look forward to receiving the views of this Committee on the issues and options, and I will be pleased to answer any questions.

Senator STEVENSON. Mr. Frank, why are you proposing to set up a separate satellite remote sensing system, instead of a system that includes all kinds of remotely sensed data, independent of the platform which collects the data?

Mr. FRANK. We do believe, over the long run, that efficiencies may be able to be obtained from combining satellite systems, but we do not think that can be done, however, in the short run.

Senator STEVENSON. I am not talking about just satellite systems; that is the point. Why not nonsatellite systems? Aeronautical, for example?

Senator SCHMITT. If the chairman would yield, I would add to that question: What is going to happen to the NASA Aeronautic program that is integrated currently with the Landsat effort?

Dr. FROSCH. It is our presumption that we would continue that, as necessary, as part of the research and development effort to improve product and technique. Our aircraft systems are normally not used directly as operational systems—although they are sometimes used in support of that—but principally as part of the R. & D. effort.

Mr. FRANK. Does that answer your question? Or should I add to it?

Senator STEVENSON. I would be happy if you could add to that. We are not designing the kind of system that I think both Senator Schmitt and I had in mind. We had a view to utilizing all appropriate sources, including aircraft, including data archived now, at EROS, for example, which is mostly remotely sensed data taken from aircraft.

Senator SCHMITT. And appropriate ground-based collection that integrates remotely sensed information.

Senator STEVENSON. Yes.

Mr. FRANK. The decision by the President was not to proceed in this fashion. I believe it was felt that from an operational point of view it would simply be better to have those responsibilities stay with the various mission agencies. Because of the nature of the responsibilities, they could best perform them. Also, in some cases those aircraft are used for a variety of purposes and would best be left where they are, rather than integrated.

Dr. FROSCH. Mr. Chairman, if I might comment, as you know we have looked at this concept with regard to the Earth-related data collection systems that NASA uses in its R. & D. and have started some work with regard to making those compatible with each other. The essential problem is that, at the present time, if one wants to use the different kinds of data bases to which you refer, the first task is to work on each of the sources of data to put it in such a form that they may be used compatibly. That seems somewhat unnecessarily complicated, even for the NASA data bases. We have begun to try to move toward a system where an all-source kind of arrangement can be used with all kinds of data used together. Our initial idea was in fact to proceed to that rather rapidly. But it is clear that it will have to be done in an evolutionary way.

Now, I say this just as a statement of experience. I suspect that we will want to evolve in the direction where users can use all sources of data most conveniently. But, I do not think that can be done at a single stroke by setting up a single system; and I am completely convinced that it cannot be done by setting up a single data base. What we will evolve toward is a set of data bases that are compatible and interlinked, so that a user can have access to all of them.

I do not think it would be a good idea to try to sweep all of the available data into one institution right at the beginning. I believe that would lead to a collapse of the capability of the user data.

Senator STEVENSON. But that should be an objective—a central location.

Dr. FROSCH. I would not say that a central location should be an objective, because that would produce a massive institution that would not really be able to keep track of what it had. It is much more sensible to think about a network system in which organizations continue responsibility for the data that they are primarily concerned with while working toward a system where that data can be compatibly used; that is, through a system of data standards and arrangements, and through a networking arrangement where a given user can have access to different kinds of systems.

Mr. FRANK. We are presently working on that subject—the cataloging of data—so that regardless of where the data comes from, it will be accessible to a user.

Senator SCHMITT. Mr. Chairman, if you would yield further?

Senator STEVENSON. Senator Schmitt?

Senator SCHMITT. Dr. Frosch, this whole business of working out how to use remote sensing in the broadest sense has been one of the most stumbling efforts that I have ever been exposed to—and I am talking about even in the early days in NASA when I was at the Johnson Space Center. It just seemed that here we had a technology of tremendous potential, and still of tremendous potential, and we have just never been able to get our arms around it in a systematic way to understand how to use specific aspects of that technology, or to integrate it.

There have been some successful efforts on the part of NASA, on the part of the Department of the Interior, and the Department of Agriculture to integrate space-, air-, and land-based sensing systems with other types of systems involving the atmosphere, and data that NOAA would provide for programs like LACIE and the follow-on AgGRISTARS, the geothermal efforts on the part of the Department of Interior, and NASA's efforts in disaster situations, as well as general observations of crop disease and so forth.

And here you are still saying that it is going to be sometime in the future when we actually try to put together a program that integrates all of these things together, when that has really been the thrust of a great deal of the R. & D. to date for 10 years or more.

I do not see why it is such a mystery. We have been trying to do it for a long time, and it has been done successfully on a limited scale.

Dr. FROSCH. I do not think it is a technological mystery. What I am saying is that the technological successes to date—indeed, more than technological, in many cases quasi-operational successes—in putting together different kinds of data, tell me precisely that the successes arise in a way which is tailored to the problem at hand.

I am skeptical that trying to set up a universal data base will facilitate solving that kind of a multidata-base problem, or it will simply lead us into spending a tremendous amount of effort and time in trying to solve institutional, organizational, and technological problems that come from too large a data base.

As far as I am aware, there has been no attempt to construct a gigantic, all-source data base, and then use it, that has ever been successful. What they normally do is fall of their own complexity, creating more difficulty. This is why this idea of networking systems has seemed more attractive.

Senator SCHMITT. I do not have any problem with that, and I am not sure that Senator Stevenson was implying that we construct a large building, a physical plant or something else that would house all the data in one place. But the planning has to, I would believe, provide for the organizational, and presumably electronic integration of the various data bases so that you have a flexibility for a perceived problem now, or one which you have not perceived, and you can tackle it immediately by the integration of the appropriate data and activities wherever they may be located.

I mean, as you say, that is certainly networking. That is certainly not something that is unusual to us, now, in many areas of defense as well as commercial activities.

Dr. FROSCH. I would agree with that as an objective to be working toward. I will make a prediction. My prediction is that we will get to that, and we will absorb into such a network system data which is coming on line gradually. But I believe we will never rework the archive for total compatibility, because I think it would be nearly impossible to do that.

The earlier parts of the archives particularly will always have to be reworked as special-case compatibility. You have to remember that even if we were to discount the data generated due to radar capabilities, satellite systems generate data at an extremely high rate. This is particularly significant when compared to some of the classical data rate problems. In essence, our satellite capabilities would create many unique networking problems.

Senator STEVENSON. What should be done for fiscal year 1981 in order to move forward as expeditiously as possible with implementation of the transition plan? You indicated, I think, Mr. Frank, that the interim system ought to be operational by 1989. You indicated that the fully operational system should be going by 1989, and I think implied that if it wasn't there would be a large risk of losing out to foreign competition.

Should not we try to authorize adequate funding for implementation of this plan in fiscal year 1981 to get it started as expeditiously and efficiently as possible? And if so, what would be an appropriate amount?

Mr. FRANK. Our feeling is that we can, with authorization in fiscal year 1982, make the 1989 date. Obviously, if you get money earlier, you might have a system earlier, and you have more assurance that you will meet your date. The initial funds that would be necessary for the fully operational system—I am not now speaking about the interim system, but the fully operational system—would be funds that would be in NASA's budget. Perhaps Dr. Frosch should indicate to you the benefits he sees in 1981, as opposed to 1982.

The basic answer to the question of "why not?" I guess is: The administration and Congress have not made the ultimate decisions. If those ultimate decisions could be made in a time frame that would allow a fiscal year 1981 authorization, then perhaps it could go forward.

Senator STEVENSON. And what would be an appropriate amount in order to reduce these risks and move forward expeditiously for NOAA in fiscal year 1981?

Mr. FRANK. Could I ask Dr. Frosch to answer that with respect to the fully operational system? Because the earliest funds for the fully operational system, will be needed by him.

They would come to NOAA for the interim system.

Senator SCHMITT. Mr. Chairman, that is semantics. What they call fully operational, you and I might call "second generation operational system."

I think you and I both believe that it would be possible to have a good, if not excellent, operational system utilizing present technology between now and when they say that their fully operational system would be available. What you and I would call operational, they call interim operational. So it is a semantic problem, and I am not quite sure why we are playing those games, but we are.

Dr. FROSCH. Mr. Chairman, if I might comment, I think I am on record before this committee several times as testifying that as far as I am concerned, we have already been operational with the system as far as many users are concerned. Unfortunately, I feel that although we do quite well with the R. & D. system, we do poorly with the operational aspects.

I think the key point on the interim operational system is that there is nothing we really can do very successfully between now and 1985 or 1986, except to proceed with our appropriate plans for Landsat-D and D'. We have already, as you know, amended in the President's amendment the 1981 budget with regard to Landsat-D and D', and I believe that that has, in fact, already been authorized for the 1981 budget.

So that as far as we now know, we have taken the necessary actions with regard to that part of the system for the 1981 budget.

I think a more significant, ongoing question is: "What actions either NASA or NOAA, or the two in concert, will have to take for provision of what happens after Landsat-D and D' are available, and whether we need to provide—NOAA with spares and backup?" I think that issue is not properly timed as a 1981 budget decision, but as a 1982 budget decision just from the nature of the leadtimes involved.

The fully operational system, or whatever the later generation of sensors is beyond the current MSS and Thematic Mapper family, depends on the solid-state technology that we have been looking at for some years. As you know, that issue has been discussed very heavily, but, in fact, is not in either the 1980 or the 1981 budget. That too needs to begin to be funded as a technology effort, and it is certainly a 1982 issue.

Senator STEVENSON. I am not asking about funding for research. In fact, I should think the funding for the research would depend on the requirements of NOAA in its implementation of this plan and in its efforts to go operational.

What I am trying to find out is how much NOAA needs in order to move ahead as expeditiously and efficiently as possible in fiscal year 1981. I had been under the impression that at least $15 million would be needed by NOAA, and consequently we proposed—in fact, we put $15 million into the climate research bill for fiscal year 1981, subject to certain understandings with Senator Schmitt, all of which were dependent on some progress from the administration.

How about you, Mr. Johnson? What is needed by NOAA in fiscal year 1981 in order to get this program moving ahead as expeditiously and as efficiently and with as little risk as possible?

Mr. JOHNSON. Thank you, Mr. Chairman.

One of the problems that we are confronting right now is what will be the actions of NASA with respect to Landsat-D and D'. The uncertainty surrounding the revision of that program makes it very difficult to come up with an accurate estimate of what, if anything, is needed in the fiscal year 1981 request.

If the Landsat-D spacecraft is going to be launched in the middle of the latter part of 1982, then it takes off considerable pressure as far as resources being required in 1981 with respect to what we call the "interim operational system." It would be helpful to assure a higher probability of continuity following D and D', again depending on the launch schedules, if we proceeded with long lead parts for additional spacecraft.

The decision as to how many additional spacecraft may be needed is highly dependent upon the level of service that is to be rendered, such as whether you have continuity in space with no gaps when a spacecraft fails. That would require backup spacecraft to be in orbit ready to operate on a moment's notice.

If you accept a gap of 6 months to 1 year to replace the spacecraft, then you would need fewer satellites. These kinds of decisions have not yet been made.

The second area where additional resources might be useful is an upgrading of the ground system that NASA is installing to operate with Landsat-D. However, there are also uncertainties, because NASA is reexamining the current design of the Landsat-D ground system, with the intention of making changes in it.

Until we know what those changes are, and therefore what the performance characteristics will be, it again is extremely difficult for us to estimate what additional resources would be required to achieve an operational level of performance.

Senator STEVENSON. You are suggesting, then, that we let another year, fiscal year 1981, slip and not put $15 million in, as we understood earlier would be desirable? Let us leave OMB aside and just give us your personal preference, if you will.

Mr. FRANK. Let me suggest this from two points of view, Mr. Chairman. I think we had a semantic problem earlier when you mentioned 1989. I thought we were talking about the fully operational system.

With respect to the interim operational system, at one point we did think it would be useful to have funds soon for a variety of the activities which Mr. Johnson has mentioned, activities which would be oriented toward increasing and insuring continuity and reliability, as set forth in my testimony.

Senator STEVENSON. You still want to assure continuity? No gaps?

Mr. FRANK. That is correct. Because of some delays that have occurred, we concluded that those funds were not necessary, for example, in an amendment for fiscal year 1981. In fiscal year 1982, assuming we want continuity and reliability referred to in my testimony, we would need tens of millions of dollars. I can give you

some specific figures if you would like, depending on which level we wish to go to.

Some of those funds could be given to us earlier; however, that would assume that basic decisions were made on what the fully operational system would be, and when we would have it, on how NASA is going to proceed with respect to Landsat-D, and on what the interim system should be. In other words, if those decisions can be made then we could proceed a year earlier.

Senator STEVENSON. When are those decisions going to be made? These are the options in the transition plan?

Mr. FRANK. That is correct. Basically they would be made looking at that transition plan, and also looking at the fiscal year 1982 budget.

Senator STEVENSON. So you are suggesting that we cannot get started in 1981, authorize money in 1981, because we are not going to make these decisions until 1982. But if we made them earlier, we could get started in 1981.

Mr. FRANK. That is correct.

Senator STEVENSON. Why are we not making them earlier? It has been dragging on for long enough.

Mr. FRANK. Well, looking over the last year or so, I think things have been progressing quite quickly. The President has made a number of decisions. We have moved forward with the transition plan, which is going to be the basic document on this subject. It provides a great deal of information.

If decisions can be made by Congress and the administration earlier, then of course we could move forward in 1981. But that is not the time frame which we are proposing.

Senator SCHMITT. As Winston Churchill said—probably quoting somebody else: "Change is often mistaken for progress."

Mr. FRANK. Senator, I am as anxious to move forward on the subject as you are. We have asked for a supplemental for fiscal year 1980, and even that had difficulties in the House.

Senator SCHMITT. The reason it is having difficulties is that, once again, the Congress is faced with a major change in orientation—managerial orientation—and nobody sees the administration really aggressively coming up here and saying they really want to do anything, other than change the responsibilities within the Government. It really is not a high priority effort on the part of the administration.

I do not mean it should be comparable to our national security or anything like that, but it just does not come across as something the White House is really particularly interested in. I know you guys are interested in it, but it is awfully hard to see that this is something that the administration is really willing to fight for.

Senator STEVENSON. We have both introduced, as you know, legislation. We have held hearings. These are not the first. The only thing that has been holding us up from acting on that legislation has been the willingness on our part to get the recommendation of the administration first.

Mr. FRANK. There were a number of rather significant sophisticated issues that were examined in the transition plan. That transition plan took only 6 months to prepare. It seemed to me that

those issues had to be analyzed in that way before any decisions could be made. I think we have proceeded as quickly as we could.

In terms of the President's making decisions and his commitment, I think his commitment is very significant as his statements have indicated. He has indicated that there will be continuity, and he has indicated that there will be an operational system.

Senator STEVENSON. Well, it is beginning to look like NOAA will receive only minimal funding for an operational system in fiscal year 1981. Therefore, NASA's budget will represent the principal investment in the remote sensing system in fiscal year 1981.

What is your best estimate of the funding required for both the NASA and the NOAA to carry out the transition plan for the subsequent years with your recommendations?

Mr. FRANK. I am going to have to give you some very speculative figures. They do not represent a position of the administration. I do not have authority to request it from Congress. I can give you some figures of what we think the fully operational system may cost.

Focusing on what we consider the "fully operational system"—that is, the system from 1989 and on—the systems we are looking at range from $1 billion to $10 billion over a 10-year period, excluding stereoscopic coverage, which would be an extra $700 million. We are focusing in on a system that is likely to be in the midrange, somewhere around the $2 billion range.

We could, if you would like, break down for you what would be the yearly budgetary requirements for NASA and for NOAA to cover such a system. But I hasten to say that we have not decided yet that that is the specific system we ought to have.

Senator STEVENSON. Could you give it to us for different systems?

Mr. FRANK. Yes, I think so.

Senator STEVENSON. That would be best if we could get that for the record.[1]

Mr. FRANK. With respect to the interim operational system, a judgment again has to be made as to which level of interim operational system you would go to: whether you would stay with Landsat-D or D', for example; what you do with Thematic Mapper, and the like.

Assuming the more or less optimal interim system which has been described in the testimony, I can also break that down in dollars. We are talking a range of $100 million to $200 million a year, starting in fiscal year 1982 through fiscal year 1986, in 1980 dollars.

Senator STEVENSON. Senator Schmitt?

Senator SCHMITT. Thank you, Mr. Chairman.

Gentlemen, on other issues I have had the impression that the administration likes to postpone things beyond the useful life of the administration—the theoretical life, at any rate—whether you are talking about nuclear waste management, or some major defense system investments, or Earth resources information systems.

In your statement, Mr. Frank, you have a list of four performance standards that would define your fully operational system. Can it be said that those four standards are designed to avoid

[1] On October 1, 1980, the committee was informed that NOAA was unable to furnish the precise information requested due to restrictions imposed by the Office of Management and Budget.

calling anything, or working toward, an operational system with existing technologies?

Mr. FRANK. Could you repeat that, Senator, the question?

Senator SCHMITT. It seems to me that by the overly broad nature of those performance standards, that you have made it possible to talk about a fully operational system, while at the same time avoiding the development of an operational system that would serve a significant range of user interests.

For example, No. 1, sensors designed to generate data meeting a broad range of user requirements at reasonable price.

The Landsat system and related technologies, including that of aircraft, can today meet a broad range of user requirements at what is a reasonable price, so long as the Government is involved in the action.

Why do we really have to distinguish between "interim operational" and "fully operational"? Why cannot we say that within the next 4 years we are going to have in place utilizing the existing state of the art an operational remote sensing system that serves a broad range of user requirements at a reasonable price? Cannot we say that? Why do we have to wait until 1989 or 1990?

Mr. FRANK. Yes, sir. You have raised two issues. One is, in effect, whether the experimental system is this system? Or whether it could satisfy these requirements.

The answer is "no." That is, neither Landsat-3 nor——

Senator SCHMITT. I know it cannot satisfy those requirements, because you define the requirements so it cannot satisfy it. What I am saying is: Why cannot it be an operational system with a different set of requirements?

Mr. FRANK. We do not believe that the present experimental system is good enough to be called an "operational system." It was intended as an experimental system, and it does not satisfy certain of what we consider requirements for an operational system.

Senator SCHMITT. Well, it comes very close to satisfying the requirements of the Department of Agriculture for their preliminary crop evaluation effort. The LACIE program was quite successful.

Dr. FROSCH. It satisfies the requirements of an experimental program, but not the requirements of an operational program. A good deal of what was done with LACIE, while it was productive, was very slow and much behind what agriculture really feels it needs for decisionmaking. Some of it in fact was——

Senator SCHMITT. But with the state of the art, Dr. Frosch, of Landsat and what we know about how we can handle data, and with the repetitive coverage that is possible with Landsat systems, we could have an operational AgRISTARS or agricultural system. Right? AgRISTARS is based on Landsat technology, is it not?

Dr. FROSCH. One can certainly make an investment in the current state of technology sufficient to have a reasonable operating system, but not one that would satisfy all the requirements of even most of the users.

Senator SCHMITT. But, you see, what I am getting at, you are trying to encompass all of the users in what you define as an "operational system." For many users, you are very close to an

operational system now. That is all I am saying. You call it interim.

Mr. FRANK. Senator?

Senator SCHMITT. It seems to me what you are trying to do is to create an environment in which you do not have to invest in more Landsat systems, and you can postpone to somebody else's administration the investment in the fully operational system.

Mr. FRANK. Senator, I think that is wrong, and maybe we have a semantic problem again. We would be happy to change the term "interim" to "operational system."

Senator SCHMITT. Well, only change it if you are going to change your attitude. I think it correctly reflects your attitude.

Mr. FRANK. No, sir. What that was intended to reflect was the fact that we were going to use generally the present technology upgraded. We did not feel that was enough. We wanted to go to a different kind of system ultimately which would be better——

Senator SCHMITT. Of course it is not enough. I want to go to a different kind of system; everybody does. But for crying out loud, for over a decade we have been working toward a system that will provide many classes of users with a great deal of useful and important information. Now it seems to me the groundwork is being laid to be able to justify not developing that system while we try to leapfrog it in 10 years.

Mr. FRANK. That is not our intent, sir. We could change the name, "interim operational system," to "first generation operational system," if that would satisfy this problem, and then also go to a "second generation" in 1989. I think it would be unwise, however, to call the present Landsat-3 and Landsat-D, which were intended as experimental systems, an operational system.

Many users would conclude that they are simply not operational; they do not satisfy enough needs.

Senator SCHMITT. They do not satisfy me, either; but I say the state of that technology and the state of the art of the development of that technology could become an operational system in a very short period of time.

Mr. FRANK. That is absolutely correct, and that is precisely what we are saying. We agree with you 100 percent—upgraded both in the ground system and in space, the Landsat-D system can be an operational system. We just use the words "interim operational system" to show that it is interim to something which is substantially improved and involves new technology.

Senator SCHMITT. Well, I will believe it when I see the three of you and the administration standing side by side up here arguing for Landsat-E.

Dr. FROSCH. Well, I suspect there will be a stage even before Landsat-E in which there will be an argument for Landsat-D—I do not know what the right litany is—Landsat-D-3 or D-spare, or ground-spare——

Senator SCHMITT. I think you are quite right.

Dr. FROSCH. Plus a major upgrade of the existing ground processing system. Those are the two patch-up requirements that are needed to keep the system much more operational than it is now. I believe there is likely to be a Landsat-E, but whether it turns out to be the same as or a slightly modified later version of Landsat-D,

or whether it becomes a later complete block change to new sensors, is not at all clear.

I think a good deal of that is covered in the plan in terms of the discussion of spare satellites, the refurbishment of Landsat-D, and the building up of a more capable ground processing system, which we should not lose sight of because it is the ground processing which has been as much of a difficulty in providing user services as the spacecraft themselves.

Senator SCHMITT. I agree with everything you have said, Dr. Frosch. Whatever you call it, the proof of the pudding is going to be whether or not the administration starts with the fiscal year 1981 budget in fighting for the kinds of funds necessary to rapidly implement a Landsat-based operational system. And I am not convinced that they are going to do that. And nothing I have heard here today has convinced me that they are going to do it.

Mr. FRANK. A decision has simply not been made on that subject, but you are entirely correct that the present system is an experimental system and if additional funds are not added to it it will not become an operational system. You are also correct that we can have an operational system with the Landsat-D technology.

Senator SCHMITT. What is an "experimental system" to the Government is an "operational system" to 30 States, and to many other users out there. It could be far more operational if we would just let it. But I do not detect a commitment to that.

I am not saying it is going to be self-supporting. I know it is not going to be self-supporting, but no system is going to be self-supporting unless we start to take some risks and start to go out and find out just what are the limits, if any, on the utilization of remote sensing. We have not taken the stops off yet.

Mr. FRANK. The decision on commitment will be made within the next 6 months, Senator.

Senator SCHMITT. Well, I will leave this, but what bothers me is that you say that the administration has made all these great decisions, but they still have not made the decision.

Dr. FROSCH. It is my assumption that an administration commitment has in fact been made; that the key point for turning that into a realization is going to be the 1982 budget which will have to include, if it is a real commitment, the provision for what is necessary for continuity of the Landsat system, whether it is called interim or final or experimental, both in spacecraft and in ground processing, and the beginning of work for the follow-on system. That is my interpretation of the meaning of the commitment not only to continuity of data, but to having an operational system. I expect to have that worked out in the course of the 1982 budget.

Senator SCHMITT. I think, Mr. Frank, your statement is a good statement of the options. It is an option paper, and we must recognize it as such. It does not represent any significant decisions, and that presumably the 1982 budget will start to sort things out and make some decisions based on those options, if we continue on this course.

But within that, if you assume that there is some inclination to have considered as one of the options Federal operation of the interim and fully operational system, what is the incentive for the

Federal Government to really push and do that job well, in contrast to the profit incentive that might exist within the private sector?

Mr. FRANK. I agree with you that the profit incentives that might exist within the private sector add to the incentive to go out and do a good marketing job. That is one of the reasons why the President decided to move to the private sector, and that is one of the advantages of private sector operation.

Senator SCHMITT. The President decided? Is there a decision on that?

Mr. FRANK. Yes, sir. The President decided that we would work toward eventual ownership and operation by the private sector.

Senator SCHMITT. I am sorry to interrupt you, but you would say that in each of the four options mentioned in your statement, that that is reflected? That Presidential decision is reflected, even though option four would be Federal agency ownership with private contractor operation?

Mr. FRANK. Yes, I can read two things.

Senator SCHMITT. You are not considering the option of Federal agency ownership and operation?

Mr. FRANK. We did not consider an option of Federal agency ownership and operation indefinitely, because the President had given us the instruction that there was to be eventual ownership and operation by the private sector.

Dr. FROSCH. I can quote it. "Other space policy decisions developed by this review and announced today are:"—and this is from the formal announcement of the decisions: "The Commerce Department will seek ways to further private-sector opportunities in civil land remote sensing activities through joint ventures with industry, a quasi-governmental corporation, leasing, et cetera, with the goal of eventual operation of these activities by the private sector."

Senator SCHMITT. Excuse me for interrupting you. Now what incentives do you see for the Federal Government to pursue that vigorously?

Mr. FRANK. We have the same incentives here, I believe, that we have generally in running our programs. We would like to see the system serve the national good. The system will best serve the national good if you maximize users. Where they were talking about maximizing return from users is a different thing. But maximizing "usage" is something a Government agency attempts to do, just as well as the private sector.

The private sector will probably be more inclined to maximize returns, not just from usage but, for example, by charging more so it can have additional profits. I admit that Government agencies are less inclined to maximize returns, in that sense.

Senator SCHMITT. And consequently, probably less inclined to maximize the user base that they would appeal to?

Mr. FRANK. Well, I am not sure of that. I look to our own meteorological satellite information, and we engage in a rather substantial effort to have it used. I have not seen the same incentive within the agency to charge for it.

Now there are a number of reasons for that. Generally when you charge for it, the money goes back into the Treasury, so an agency itself, unless you have a special arrangement, does not benefit. And

indeed it is just because the agency wants to maximize usage that it does not charge, because it feels that if you do charge there is less usage. You force a potential user to start balancing increased use versus increased cost. Where information is free or relatively free, there is likely to be more usage.

Senator SCHMITT. How much do you think tradition plays in this, however? Tradition established over time that the Weather Service is a governmental service, the Postal Service is a governmental service versus other types of activities that relate more directly to commercial sector consumption of the information?

Mr. FRANK. I am sure that history leads us to certain situations. For example, we have a National Weather Service. If history had led us to have a private weather service now, I do not think we would be discussing starting a national weather service.

Senator SCHMITT. Well, that is not clear. There may be a very basic difference between operational remote sensing data and operational weather data. Namely, that the average citizen individually is much more involved in using weather information than they will ever probaby be involved in using remote sensing information.

I think it unlikely that you will have an evening remote sensing report; but it is highly likely you will have an evening weather report since you have them already. The same goes for the Postal Service. The Postal Service is something every individual American utilizes and expects to have as a service provided by their Government. Again, I draw the contrast to remote sensing.

Dr. FROSCH. Mr. Chairman, if I may, I would like to quarrel slightly with you, Senator Schmitt. I can visualize, at least in special circumstances, the use of almost live remote sensing data in much the same way that weather data is used——

Senator SCHMITT. Oh, I can, too.

Dr. FROSCH [continuing]. With the same kind of excitement about environmental events of the simplest kind: Obviously, floods, drought, and the state of agriculture would be not only a piece of national reporting and global reporting, it could be a piece of regional and State reporting. One can almost write the script. The state of fields in such-and-such in our area is, and here is the picture, and so on and so forth.

Senator SCHMITT. Dr. Frosch, I can imagine that, also. But I think you will find that the balance——

Dr. FROSCH. Most of it is going to be technical use.

Senator SCHMITT [continuing]. Is well over on the side of the commercial use, or governmental use, of data rather than individual use. But I can. As a matter of fact, I probably alone in this room have guided an array of communications aircraft away from a hurricane by observations from space. So I clearly believe that it will have that kind of an operational thing, and I think in remote sensing the same thing can happen, whether you are talking about a volcanic dust cloud, or talking about floods, or what-have-you. And that is a hazard-avoidance capability of remote sensing that is in many cases right now beyond the capability, the real-time capability of the Weather Service. I think that will come, and it will all suddenly start to merge together.

But in terms of maximizing the benefits of remote sensing, I think you are going to find they are only going to be maximized if

there is heavy commercial sector involvement in the use of the information—commercial and governmental involvement.

Dr. FROSCH. Could I comment on that? I think we have to distinguish between several places in which the commercial involvement can be. For the purpose you were just mentioning, we might separate the system at the ground readout of data. It is not clearly the case that commercial ownership of the space segment would necessarily do anything for stimulating the users; whereas, pushing the transformation of data into information and product as a commercial enterprise certainly will and already has. I do not intend that to be an argument against commercializing that space sector; only to note that commercializing the transformation of data to information can be done, and is in fact already underway and can be done rather rapidly and easily, and does not face the large investment requirements that commercializing the space sector does.

It does, however, face the Freedom of Information Act difficulty in terms of whether that legal instrument forces the Government to be in competition with the private sector.

Senator SCHMITT. Well, we certainly can examine that problem, but I think you would have to say that right now the marketplace literally has only indirect control over the research and development and what is actually put into space, except what they are given by the administration working through the good graces of the Congress.

Dr. FROSCH. But in fact, it is exactly an attempt to get some marketplace control of what is eventually put into space that led NOAA, to do all of that interaction with the potential users. That, in fact, is what has led the group that put this together to place these rather stringent requirements on an ultimate system. Some of them may be beyond what we think is sensible.

Senator SCHMITT. We still sit here between the user input and what is actually going to end up being put into space. And in the commercial sector, there are different filters: The filters that are natural to the marketplace, rather than those that are natural to politics.

Mr. FRANK. Senator, I am not sure on this issue we have a disagreement. With respect to what kind of private-sector involvement there can be, we have discussed this subject with the private sector and, as Administrator Frosch has said, there are several viewpoints. Some parts of the private sector would prefer for the system not to be owned and operated by one part of the private sector. Rather, they would like the private sector to be involved perhaps with the ground segment, as opposed to the space segment.

Senator SCHMITT. That was very true with Comsat, also.

Mr. FRANK. I am just reporting what they have told us.

Senator SCHMITT. Well, it is the same discussion. I will guarantee you, if you go back and look at the discussions surrounding the formation of Comsat you will see the same thing.

Mr. FRANK. That is quite true.

There is then a second issue of—and an important one which you raised—whether the private sector or the public sector is inclined to get this thing off the ground faster, and also in particular which one will do marketing better. And I think arguments can be made in both directions. That is, it can be argued that the private sector

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will do a better market development program, because it is interested in profits; it also can be argued that if you are going to provide the service at Government expense, then the Government tends to do it better because at least it is free.

There is also the question of at what point the private sector will take over some assumption of risk here, and therefore will be prepared to take over the system. That is, one could reasonably conclude that it is not a good idea to have the private sector own the system when it is totally subsidized by the Federal Government.

Senator SCHMITT. That is where you provide for transitions, as you provide in your option.

Mr. FRANK. That is correct, sir.

Senator SCHMITT. Such as the formation of the Comsat-like corporation. You provide that, and as you know in the case of communications, very quickly the total risk was assumed by the private sector.

Mr. FRANK. But the President has decided that there will be eventual operation and ownership by the private sector. We have suggested four alternatives. It seems to me that the first two of those alternatives are preferable, and you should only turn to alternatives three or four if the first two cannot be achieved.

Senator SCHMITT. Now, Mr. Frank, on the selection between the various options, presumably the initial filtering will be done as a result of the ongoing fiscal year 1982 discussions. Is that correct?

Mr. FRANK. Which options are these?

Senator SCHMITT. The various options you have in here.

Mr. FRANK. The options of ownership, now?

Senator SCHMITT. No, just generally. As you start to filter through the option paper, if you will, then you will start to sort out these things. The first sorting process is occurring as a consequence of the fiscal year 1982 budget process. You and NASA are both subject to that, and I would ask: Are you doing that in a coordinated way? I mean, in this part of your respective budgets are you working directly together? And does OMB expect you to have a joint presentation?

Mr. FRANK. Whether it will be formally a joint presentation, I do not know. I think it would have to be integrated in that fashion. We are working together. As Administrator Frosch said, the relationship between NASA and NOAA has been outstanding. There have been no two agencies that have worked together better. I credit Administrator Frosch for that, and also his staff and my staff.

Yes, we are working together. Not only we, but the other agencies, the potential user agencies, are very much involved in this process.

Senator SCHMITT. Well, I think that cooperation clearly has been outstanding—among the best in the Government, if not the best. I am sure it can continue.

My interest is whether OMB expects you to have integrated your budget request in this area.

Dr. FROSCH. I think they do, although I have not discussed this particular prospect in detail. We have been informed that it will

have to be an integrated presentation, but exactly what form the discussions will take I do not know.

Senator SCHMITT. Now with respect to the performance standards that are applicable to the fully operational system, will those be reviewed in any formal way with an advisory group within the Government itself? What mechanism will exist to finalize this? Or do you consider that process having run its course, and these are final performance standards?

Mr. FRANK. We do not have final performance standards at all for the fully operational system. I mean the new technology after 1989——

Senator SCHMITT. No, I can use your terminology.

Mr. FRANK. All right.

Senator SCHMITT. I can be critical of it and still use it.

Mr. FRANK. A decision will be made over the next year on the specifics of that program, and that would be done with continuing collaboration with the private sector.

We already have had a substantial amount of participation by the private sector and other agency users, and their views as to their needs, as to whether they would be minimally satisfied, moderately satisfied, or completely satisfied is reflected in a chart in the document that has been given to you. So you can see from that chart what their desires are.

Now ultimately you have to balance desires against costs and what you expect, for example, to be revenues if you are going to have a system that pays for itself.

Senator SCHMITT. Now do you anticipate having some kind of a formal scientific technical advisory group, an economic advisory group?

Mr. FRANK. Yes, sir.

Senator SCHMITT. Will you go through the Academy for that kind of assistance?

Mr. FRANK. No, sir. We will have an advisory group that is mentioned in the report that would include the elements of the private sector that would be interested in this subject. Now that will primarily be users at this point, but could also include industrial people who might be involved in the manufacturing sector and who have no interest in use.

Initially it could involve potential operators, although ultimately that committee—if there were an advisory committee—would not, because you would have your operators selected. It might involve individuals who are disinterested from those points of view, but who have scientific competence or economic competence and would be involved as more or less objective persons.

Senator SCHMITT. Now that would be the group that you would anticipate to provide you with your technical advice on a decision between the four options?

Mr. FRANK. It is not only technical advice, but advice as to what they desire, for getting the technical point of view, and also economic advice.

Senator SCHMITT. Well, I meant "technical" to cover a very broad——

Mr. FRANK. Yes, "technical" covering the broad range.

That group, by the way, would not be intended to preclude input from other parts of the public who were interested. That is, I do not think anyone has to assume that his or her interest is going to be represented by that group. I think it will be by some parts of that group, but no one need assume that. And if anyone wants input into us with views, they will certainly have that opportunity.

Senator SCHMITT. Senator Stevenson apologizes for being called away, but the battle continues.

Dr. Frosch, he wanted me to ask you a few more questions. To carry out the recommendations of the transition plan, there will have to be an aggressive research and development effort, and it is recommended that this R. & D. be done by NASA. In your view, what research and development projects need to be initiated or continued in fiscal year 1981 to accomplish what is recommended by the transition plan, recognizing that the 1981 budget was submitted before the transition plan went through.

Dr. FROSCH. What the transition plan does, from our point of view, is reemphasize the importance of making early decisions on Landsat-D and -D', and getting the best we possibly can. It will have to be a compromise between maximum technical performance and early launch of those satellites to try and keep the data continuity as strong as possible. It also emphasizes the continuing work we are doing in the ground processing efforts that go with that. I think those are the highest priority items. As I mentioned before, I believe we have covered them adequately in the revisions to the 1981 budget.

Senator SCHMITT. What about the multilinear array?

Dr. FROSCH. I was going to go on to say that that is the next principal technical step—the extension of the solid state technology required for all the needed bands. That is the next task that has to be taken up. That appears to be the principal really new piece of technology that we must work on.

Now, there are other potential technological things on which we have done a little bit that will continue to be important. They include passive microwave sensing, particularly, and we need to continue to look at the whole question of active microwave sensors.

Senator SCHMITT. Now can you provide for the record a summary of those items—and there may be one or two others that come to mind—in research and development that are implicit in the transition plan, or in the options of the transition plan, and the schedule under which you believe that it is prudent to carry out those projects, and an estimate of the annual funding requirements, if they were going to be carried to completion?

Dr. FROSCH. Yes, I think we can do that.

[The following information was subsequently received for the record:]

R. & D. ITEMS IMPLICIT IN NOAA TRANSITION PLAN

A. RESEARCH AND DEVELOPMENT

In addition to the continuation of the development of Landsat-D and -D', including the Thematic Mapper, and the associated ground processing system, the following research and development items are implicit in the NOAA Transition Plan:

1. Continuation of the definition study for the Operational Land Observing System (OLOS), including the user requirements.

2. Extension of the technology required to develop sensors needed to meet the user requirements in the operational era.
3. Continuation of research on deriving the maximum information from the higher resolution data and additional spectral bands available with the Thematic Mapper. A strong research program has also been initiated on how to use synthetic aperture radar data, particularly with regard to geological mapping and non-renewable resource exploration.
4. Developments implicit in the NOAA Transition Plan include: MLA solid state sensor, panchromatic stero capability (15m resolution), panchromatic high resolution (2m) imagery, multifrequency imaging radar, and passive microwave imager.

B. DEVELOPMENT SCHEDULE

Development schedule for Landsat-D and -D' and the associated grounding system is currently under review. The definition study of the OLOS was initiated in fiscal year 1980 and will continue through fiscal year 1981.

A fiscal year 1982 Advanced Technology Development is under consideration for the MLA Solid State Sensor with a possible fiscal year 1983 new start for sensor development. The sensor would fly on an R&D demonstration mission in early 1987 and on the OLOS in 1989.

Panchromatic stereo capability will be considered for the MLA Solid State Sensor as part of the sensor definition studies in fiscal year 1981. Capability for worldwide stereo coverage could then be possible on the OLOS in the early 1990's.

Feasibility studies for a High Resolution Panchromatic Imager should be performed in fiscal year 1982. An fiscal year 1987 new start is under consideration with launch in fiscal year 1993.

A fiscal year 1984 new start is being considered for the Multifrequency Imaging Radar with flight on an R&D mission in late fiscal year 1988.

A Passive Microwave Imager is planned for the Soil Moisture Research and Assessment Mission in fiscal year 1990; a new start would be required in fiscal year 1986.

C. FUNDING REQUIREMENTS

$1.8M has been budgeted in fiscal year 1981 to continue the definition study for the OLOS.

Development of the MLA Solid State Sensor is presently estimated to cost $150-175M excluding the $10M required for Advanced Technology Development, with first year funding of approximately $15M and total funding spread over 5-6 years. Current plans would require first year funding in fiscal year 1983.

Addition of panchromatic stereo capability to the MLA Solid State Sensor is estimated at $25-35M spread over the fiscal year 1983-1986 time frame.

A High Resolution Imager capable of providing panchromatic images at 2m resolution is estimated to cost $325-375M spread over the fiscal year 1987-1993 period.

Cost of a Multifrequency Imaging Radar Sensor is estimated to be $150-175M, with first year funding of approximately $15M and total funding spread over 5-6 years. Current plans would require first year funding in fiscal year 1984.

Our preliminary estimate is that approximately $50M would be required to develop a Passive Microwave Imager and the antenna required for soil moisture measurements.

Senator SCHMITT. In terms of procuring additional satellites, what in your view, Dr. Frosch, should be the schedule of procurement if there is to be no gap in providing data and standard data products in the latter half of 1980?

Dr. FROSCH. It is clear that if we want to insure against the gap, then we are going to have to look at the Landsat-D and -D' schedule. We will have to decide whether we are insuring against a gap in 18-day coverage, or a gap in 9-day coverage. Namely, are we going to try to assure that there is always at least one satellite operating, or at least always two operating? On the basis of that, we will work a plan for replacement.

As Administrator Frank mentioned, it depends somewhat on whether by a "gap" you mean zero time without satellite, or whether you are willing to accept a few months without satellite. I would not regard that question as part of the research and develop-

ment issue, but rather as part of whatever phraseology we want to use, "interim" or "operational" system, rather than "research and development."

Senator SCHMITT. Mr. Frank, have you made up your own mind on what you think would be the best institutional structure for a fully operational system?

Mr. FRANK. You are speaking now about private-sector involvement?

Senator SCHMITT. Yes. The best mix.

Mr. FRANK. My recommendation would be toward option 2, which is a legislated for-profit corporation authorized by this Congress with private equity and privately and publicly appointed board members. I think that that would be the preferable one, if it can be done.

There is, of course, the question of whether or not the private sector is willing to assume the risk and willing to move forward with this. That is something I cannot answer now.

Senator SCHMITT. Why do you feel that that is the best approach?

Mr. FRANK. Well, as between the four alternatives, one and two have the advantage of being quicker than three or four. Therefore, if the objective is to move to private-sector ownership and operation, I would pick the quicker ones.

As between one and two, two has the benefit of having legislation which circumscribes certain things that the corporation can do and what it can be. And I think that there are certain specific requirements and limitations that ought to be imposed upon the corporation.

I think also that there ought to be publicly appointed board members because of the benefits that would result from that.

There is also the possibility that if you have a new corporation, that you can have a different kind of corporation from an existing one in the sense that there may not be too many existing corporations which could take this responsibility on. Many of those may have conflicts of interest. Many of the best may have conflicts of interest.

And if you have a new corporation which does not have other responsibilities and does not have those conflicts, then you take care of some of those problems.

Senator SCHMITT. Do you also see that option 2 can legislatively build in the flexibility necessary to move towards a self-sufficiency that might otherwise not be possible in the other options?

Mr. FRANK. I am not sure that No. 2 would be——

Senator SCHMITT. Well, let me give you an example. Under Comsat, there was a Federal ownership of Comsat stock that was fairly—could have been fairly large in the early stages, but there was a range in which it could operate depending upon the need for capital. Those kinds of things can be built in legislatively to that option and may not be possible in option 1.

Mr. FRANK. That is correct. I hasten to say, everything I am saying here is a personal view and is not an administration position.

Senator SCHMITT. Certainly. I understand. And the record is clear on that.

And you feel that there would need to be some period under option 2 in which the Federal Government was committed to purchase from the corporation? That would be my gut feeling, and I am just wondering whether it is yours.

Mr. FRANK. There would have to be a commitment by the Federal Government, a financial commitment, to this new corporation, I am quite confident, for there to be any public subscriptions to it. That contribution could come about in a variety of ways. I think there would be two general ways.

One is a guarantee to purchase, perhaps at specified prices, the data so that at least the corporation would know it had a market. You could satisfy the total obligation that way by setting the price very high—probably higher than many agencies would like to pay.

If it were to be too high, then you could have in addition to a guaranteed purchase contract of some sort, other kinds of subsidies—loan guarantees, grants, price guarantees, and the like. There are a range of options.

There of course comes a point where this for-profit corporation in effect is a sham. That is, if you have Government contribution in terms of stock, if you have direct subsidies or loan guarantees or grants, and if you have a purchase contract guarantee with a high price, then it is in effect a Government entity if you have so little risk by the private sector. And in that case, I would not recommend it.

Senator SCHMITT. But clearly the legislation should provide the incentives to minimize that level of activity, and reduce it with time.

Mr. FRANK. That is correct. There will be an interesting balancing of not wanting to get the Government risk to be 100 percent. You start out with Government risk being 100 percent, and interest by the private sector because the Government is taking all the risk.

And then as you go down, because you do want to go down, you do not want to have it 100 percent Government, you have to find a balancing of where the private sector will come in with what Government guarantees. And I think at that point you have to look at those Government guarantees and see where you are.

If you get 100 percent, then this is not a good option. If it is at 50 percent, then of course you are in the right ball park, perhaps.

Senator SCHMITT. When do you propose, Mr. Frank, to submit legislation providing authority to NOAA to establish and operate a remote sensing system?

Mr. FRANK. We have some authorizing legislation which we have submitted to Congress which is not intended to be long-term legislation but is intended to allow us to start on this venture.

Let us assume that the decisions are affirmative in the 1982 budget consideration, so that the budget submission to Congress come January will have funds in it for operational systems. It seems to me that we would want, as quickly as possible thereafter, if not at that time, to submit legislation which would have these items in it. It may take a little longer than that to frame the legislation, only because of its complexity.

It would not be difficult to frame legislation giving us the authority to own and operate. I think framing legislation, for example for

private sector involvement, a for-profit corporation is much more difficult.

Senator SCHMITT. Do you think that you might submit legislation that would leave that option for further determination? Your intention now is to try to outline the full program in that authorizing legislation?

Mr. FRANK. I would think that the only reason to delay is if, after consultation, the administration and Congress agree that the complexity of the legislation would take a 6-month or a year's time lapse, in which case you might want to go forward with a smaller bit of legislation. It depends in part on what the authorizing legislation before you now says.

For example, let us assume that we wanted to move forward with an operational system with private-sector involvement. Before we could get fiscal year 1982 appropriations through an Appropriations Committee, I think we would have to have authorization from Congress for an operational system and for us to operate it.

So we would want that to get done at least by the time the appropriation process comes along. If it is going to take longer to work this out—and this may be very complex—then maybe we ought to have two chunks, indicating in the first one what is going to come in the second one.

I suppose our intention had always been to do it all at once, but we do have the constraints of the Appropriations Committee.

Senator SCHMITT. Well, I think you can do it all at once, so long as you assume that there may need to be modifications to it with time. I think it is a good idea to try to lay out the general picture, if you can. You may find that it is too difficult politically and otherwise. But lay that out with the recognition, and built into the legislation the recognition that it will be revisited as experience grows. This is untrod ground. I do not think we should expect to have it all right the first shot. That is the main reason we revisited the 1934 Communications Act— although it took us a long time to do it.

I think we will certainly have a number of questions for the record, gentlemen, and I hope that those can be answered promptly. I believe Senator Stevenson will also have questions, and our record will be open for that purpose.

Senator Heflin also has some questions for the record which we will submit to you.

Senator SCHMITT. Thank you. I think you have made progress in at least understanding what has to be considered. It is my personal feeling that we have a great deal more to go, and I think I have made it obvious. I hope that we see, either in front of you or behind you, more vigorous administration support.

My criticisms are not directed at NOAA or NASA, but at the level of support that I foresee you are getting from the Administration.

Thank you very much.

Mr. FRANK. Thank you, sir.

Dr. FROSCH. Thank you.

Mr. JOHNSON. Thank you.

[Whereupon, at 12:57 p.m., the subcommittee was adjourned.]

TRANSITION PLANNING FOR THE OPERATIONAL CIVIL REMOTE SENSING SATELLITE SYSTEM

THURSDAY, JULY 24, 1980

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
Washington, D.C.

The subcommittee met at 9:35 a.m. in room 235, Russell Senate Office Building, Hon. Adlai E. Stevenson (chairman of the subcommittee) presiding.

OPENING STATEMENT BY SENATOR STEVENSON

Senator STEVENSON. The subcommittee will come to order. Last November the President approved a civil space policy in which he assigned to the National Oceanic and Atmospheric Administration responsibility for operational land remote sensing activities. He directed NOAA to prepare a plan of transition for the experimental Landsat system to employee operations. The transition plan was completed early in June. And the subcommittee held hearings on it on June 26, administration officials testifying then.

The purpose of the hearing today is to give users of remote sensing data an opportunity to comment on the plan, including some of the user corporations that have indicated interest in operating or owning or managing a fully operational system.

We have a great many witnesses. I am going to invite them all to summarize their testimony as best they can. The prepared testimony statements will be entered in the record.

Our first witnesses are Joan Davenport, Assistant Secretary for Energy and Minerals from the Department of Interior; Howard Hjort, Director of Economics, Policy Analysis and Budget for the Department of Agriculture; Norman Terrell, Deputy Assistant Secretary for Science and Technology from the Department of State; and John W. Jarman, Chief of Data Collection and Management Division, Water Resources Support Center of the Army Corps of Engineers.

We thank you all for joining us. May we proceed with you, Ms. Davenport?

STATEMENTS OF JOAN DAVENPORT, ASSISTANT SECRETARY FOR ENERGY AND MINERALS, DEPARTMENT OF THE INTERIOR; HOWARD W. HJORT, DIRECTOR OF ECONOMICS, POLICY ANALYSIS AND BUDGET, DEPARTMENT OF AGRICULTURE; NORMAN TERRELL, DEPUTY ASSISTANT SECRETARY FOR SCIENCE AND TECHNOLOGY, DEPARTMENT OF STATE; AND JOHN W. JARMAN, CHIEF OF DATA COLLECTION AND MANAGEMENT DIVISION, WATER RESOURCES SUPPORT CENTER, U.S. ARMY CORPS OF ENGINEERS

Ms. DAVENPORT. Thank you, Mr. Chairman. In the interest of time, I will make a very short statement and ask that my written remarks be entered into the record.

Senator STEVENSON. It will be entered into the record.

Ms. DAVENPORT. Since 1965, the Interior Department has been an enthusiastic and positive supporter of the use of satellites for Earth remote sensing. We have developed a scientific research program to evaluate, test, and apply remote sensing technology to the Department of the Interior missions.

Our remote sensing programs have grown and they have progressed from using NASA transfer funding for support of the program to a current operating level for the EROS office in excess of $16 million. We have a major land sensing center, the EROS Center, in Sioux Falls, S. Dak. This Center has become an international focal point for the distribution and application of remote sensed data, both from satellites and from plane platforms. The Center's scientists have been called upon to provide training for others throughout the world. We work very closely with AID in these activities.

Even though under the plan we will be redirecting the prime mission of the EROS Data Center toward Interior objectives, we view the Center as a national asset that will be used to support the Nation's remote sensing needs. We are working closely with NOAA and other agencies to prepare the transition plan for civil operational land remote sensing satellite system. The planning document provides, we believe, a useful summary of the issues and options considered by the interim policy group.

Interior has consistently advocated a simple, cost-effective, and reliable land remote sensing system which we believe would be most effective in maintaining our objectives of continuity of data and increasing use of satellite imagery.

The future role of the EROS Data Center, as indicated in the NOAA transition plan, was a matter of discussion between myself and George Benton of NOAA. We have come to an agreement whereby certain distribution and archiving functions will be removed from that center, but the center's base capability of applying remote sense data to Earth science applications will be continued, and we believe enhanced, in the future.

Therefore, the EROS Data Center will become a large research Center. The Department of the Interior will continue to be a strong supporter of the national program in land remote sensing. We will be working closely with NOAA to provide support as they implement an operational system. In addition, we will continue to work with NASA to identify needs for our remote sensing system, to be developed during this decade.

Mr. Chairman, I would emphasize that through applications developed at Sioux Falls, literally every bureau in the Department of the Interior applies satellite data in the pursuit of their missions. I think I'll conclude my statement there. Thank you, sir.

[The statement follows:]

STATEMENT OF JOAN M. DAVENPORT, ASSISTANT SECRETARY FOR ENERGY AND MINERALS, DEPARTMENT OF THE INTERIOR

Mr. Chairman and members of the committee, I am pleased to have this opportunity to express the views of the Department of the Interior on the document "Planning for a Civil Operational Land Remote Sensing Satellite System—a Discussion of Issues and Options."

First, I would like to provide a brief background statement on Interior as a user agency. The Interior Department has, since 1965, been an enthusiastic and positive supporter of the use of satellites for Earth remote sensing. Beginning with transfer funds from NASA as "seed" money, Interior, through its Earth Resources Observations Systems (EROS) Office, has developed a scientific research program to evaluate, test, and apply remote sensing technology to facilitate Interior Department missions. This was, and will continue to be, the basic mission of the EROS Office. Our remote sensing programs have grown, and we have progressed from using NASA transfer funding for support of the program to a current operating level for the EROS Office in excess of 16 million dollars.

Interior's EROS Data Center (EDC) at Sioux Falls, S.D., was opened in 1972. This Center has become an international focal point for the collection, processing, and distribution of Landsat acquired data, as well as other forms of space and domestic aerial photography. EDC currently supplies data at the cost of reproduction to Earth resource scientists throughout the world.

In science, the Center has gained worldwide recognition for its expertise not only in data processing but also in the analysis and application of these data. Moreover, Center scientists have been called upon to provide training for others throughout the world. Even though we will be redirecting the prime mission of the EROS Data Center toward Interior objectives, the Center is a National asset that will be used to support the National remote sensing programs.

In reference to the planning document, we have worked closely with NOAA and other agencies to prepare the Transition Plan for a Civil Operational Land Remote Sensing Satellite System. The planning document provides a useful summary of the issues and options considered by the Interim Policy Group. NOAA has done an outstanding job in presenting the many complex policy and technical issues identified.

Interior has consistently advocated that a simple, cost effective, and reliable Land Remote Sensing System be pursued to carry out the President's commitments of continuity of Landsat-type data through the 1980's. The identification of a cross section of system options in the planning document represents an important step in the development of operationally oriented space and ground systems.

The future role of the EROS Data Center as reflected in the planning document has been developed through meetings between NOAA Associate Administrator George Benton and me. This proposal calls for an orderly transfer of the Landsat data archiving and distribution functions to NOAA by fiscal year 1984 and the reconfiguration of EDC as an Interior Remote Sensing Science Center. The EROS Data Center is the backbone of Interior's application of satellite land remote sensing data. The Center has had, and must continue to have, a key role in the development of application techniques required by Interior, the transfer of land remote sensing technology to Interior users, the processing and distribution of unique image products to Interior users, and the archiving, reproduction, and distribution of large quantities of Interior acquired aerial photography.

In conclusion, Mr. Chairman, I want to assure you that the Department of the Interior will continue to be a strong supporter of the National program in land remote sensing. We will be working closely with NOAA to provide support as they implement the operational system. In addition, we will continue to work with NASA in identifying research and development needs for the future and in carrying out experiments to validate new capabilities.

Thank you, Mr. Chairman, for the opportunity to discuss this topic before this committee.

[The following information was subsequently received for the record:]

Questions of the Committee and the Answer Thereto

PRIVATE SECTOR OWNERSHIP

Question. Would the transfer of the Civil Land Remote Sensing Satellite System to the private sector impact the use of satellite remote sensing data in your department? How?

Answer. Transfer of the Civil Land Remote Sensing Satellite System to the private sector should have little impact on the use of land remote sensing satellite data in the Department of the Interior. The quantity of Interior required data will probably grow substantially as new and better data become available. The amount of data purchased and the uses made of the data will be determined by the applications within the Department, the cost for products, and license fees for reproduction.

Question. If and when the Civil Land Remote Sensing Satellite System is transferred to the private sector, it appears the Federal Government will have to provide support during the early years. What is your view as to how the Federal Government should provide such support?

Answer. The Federal Government is now, and will continue to be, one of the largest users of remote sensing data from satellites. Interior accepts the need to charge reasonable prices for data and to protect the data to prevent unauthorized reproduction. We also recognize that product costs must be competitive with other domestic and foreign information sources.

Fees paid for data and its use will be one form of support to the private sector organization that operates the Civil Land Remote Sensing Satellite System. Alternatives to provide the required funding are under study by the Executive Office of the President and by the participating agencies.

CONTINUITY OF DATA

Question. All user agree that continuity of data should be assured, and the President directed (in PD 54) that be a prime objective. However, since both Landsat 2 and Landsat 3 are barely hanging in there, there will almost surely be a data gap. How will that affect your Department?

Answer. Interior uses satellite acquired land remote sensing data in a variety of ways. A number of these uses could continue in spite of a data gap, provided the data gap is not over six months to a year.

Other uses, involving the monitoring of Federally owned public lands for resource data and obtaining information to respond to emergencies would not be possible during a data gap.

Question. It also seems clear that unless some early planning is done to assure continuity of data following Landsat D', another data gap will occur. Have your agencies made known to the OMB the importance of continuity of data and the importance of early funding for the continuation of data acquisition after Landsat D'.

Answer. Interior has maintained since the start of the Landsat (ERTS) program that data continuity is of critical importance. This view has been expressed to OMB through budget submissions, cross-cutting reviews with NASA and NOAA, and in interagency task forces that include representation from OMB.

Moreover, Interior has indicated its support for the interagency transition plan submitted to OMB in June, which addresses the importance of early funding for the continuation of data acquisition after Landsat D'.

Question. If continuity of data is assured, then the timely distribution of that data becomes a critical issue. In what time, after the satellite acquires the data, must it be available to be useful to your Department?

Answer. Approximately 10 percent of the data required by Interior should be available within 24 hours after acquisition to be useful. The remaining 90 percent should be available within 10 to 15 days after acquisition.

Question. To provide data to the users within that time, improvements will have to be made to the ground processing system. Have the views of your Department on this issue been made known to the OMB?

Answer. Interior has worked closely with NOAA and other Federal agencies in the preparation of the transition plan recently submitted to OMB. During the course of preparing the transition plan, Interior's views on required improvements to the ground processing system were expressed in the Interim Policy Group meetings with OMB representative present, and in documents supplies to OMB at their request.

RESOLUTION

Question. How good must the spatial, spectral and radiometric resolution be from the operational Land Remote Sensing Satellite System to meet the needs of your Department?

Answer. Modest improvement in spatial resolution would increase the uses of satellite data within the Department of the Interior. For most of our applications of land remote sensing satellite data, a resolution of 20 to 30 meters would be adequate.

Experience and research suggest that some adjustment of the current Landsat spectral bands may improve the value of the data. We expect to verify these results with Thematic Mapper data so that the appropriate capabilities can be phased into future operational systems. We do not see an immediate need for a large number of spectral bands (over 5 to 7) for an operational land remote sensing satellite.

Interior uses digital data processing extensively. Radiometric resolution is a limiting factor in carrying out these analyses. We recognize, however, that atmospheric and suface conditions cause variations in radiometric quality that can exceed the noise levels of the sensor. We feel that the state of the art in sensor technology can provide adequate radiometric resolution until we can learn more about removing the effects of the atmosphere.

Question. How important is spectrol and radiometric resolution vis a vis spatial resolution to your Department?

Answer. Spectral and radiometric quality of data is of equal importance vis a vis spatial resolution to the Department of the Interior. The improvements that Interior requires are modest and within the capabilities of current technology. We also feel that improvements should be phased into an operational system at a rate that is compatible with the ability of users to carry out the analyses. For example, a factor of 20 improvement in spatial resolution would increase the data volume such that we might not be able to make immediate use of the digital data in many of our programs.

DATA SEPARATION

Question. The transition plan proposes that the spacecraft remote sensing date be separated from the aircraft remote sensing data at the EROS Data Center. Consequently, there will be at least two centers to which users will have to go to review what remote sensing data is available. Congressional proposals have been directed to establishing an Earth remote sensing capability that would include all remote sensing data as opposed to having separate systems. What are your views on the proposed separation on these data into two separate and distinct organizations?

Answer. It is important that the user community have a single source of information regarding the availability of all remote sensing data covering a particular geographic area. For domestic users this information is available through the services of the National Cartographic Information Center (NCIC) of the USGS. The EROS Data Center supports the NCIC by supplying information regarding the availability of DOI-acquired aircraft data as well as Landsat data. Many other Federal and State agencies, including the Aerial Photography Field Office of the USDA, also supply information to NCIC about the availability of their substantial aerial photography holdings. We do not feel that separation of location and distinct organizations is a major problem as long as information about the data is available in a central system such as NCIC.

Senator STEVENSON. Thank you, Ms. Davenport. We'll finish up the statements, then go back to all of you.

Mr. Hjort?

Mr. HJORT. Thank you, Mr. Chairman. I am pleased to be here with the committee here today. I also would prefer to summarize our relatively brief statement.

Senator STEVENSON. Thank you. Your statement will be entered into the record.

Mr. HJORT. We have been actively involved, very much involved, in the studies that have been underway over the last few years with respect to space policy and in the development of the document that's under consideration by the committee today. We've talked with you and your committee on previous occasions about our AgRISTARS program, our experimental activity—and in the

statement there are some brief examples, and a brief summary statement there, that in the interest of time I will skip over.

We do feel that the issues and options document is an important first step in establishing a national civil operational land remote sensing satellite system. We look forward to a transition plan that will be shaped as required to meet the needs of all the users and take account of changing technology and funding situations.

We do intend to continue to be actively involved in both review and revision of the proposed plans through the program board which has been specified in the Presidential directives as the Federal management mechanism.

From our position as a user, we have little to add to the issues and options document at this time. Obviously, our research and experimentation under the AgRISTARS program will provide some important guidance for the future. As far as operation of the civil land observing system is concerned, we are pleased that NOAA has been designated as the federal operator. We believe that in part because of its long and successful operation of the atmospheric satellite systems and our close working relationship with them on weather information.

We are concerned that data will be provided to users at a fair and reasonable cost. The Department has no objection to payment for data received from the satellite systems; however, we believe that users, particularly the smaller users, should not be excluded from taking advantage of this new source of information by prices that increase too rapidly at too early a stage in the development period of the technology.

Although the plans for an operational system deal with development of new technology, only tangentially, the establishment of an operational system has definite implications for users, implying, as it does, that various features and components will be standard. We believe that emphasis on research should be continued. An operational system which does not have adequate provision for the incorporation of the latest technology will not have full user support.

Continued research is important for two reasons. It will allow us to consider applications and activities not possible with present systems, and it will help us achieve better efficiency with the systems we now have. So in conclusion, we feel that the discussion document is balanced in its presentation of the issues and options, and provides adequate guidance for an effective land remote sensing program. Yet it is sufficiently flexible to meet changing opportunities.

Thank you, Mr. Chairman.

[The statement follows:]

STATEMENT OF HOWARD W. HJORT, DIRECTOR OF ECONOMICS, POLICY ANALYSIS AND BUDGET, DEPARTMENT OF AGRICULTURE

I am pleased to represent the U.S. Department of Agriculture (USDA) in this panel discussion of issues related to land remote sensing for space and transition of U.S. activities in this area from experimental to operational status. The USDA is a "user" of remotely sensed data in research and operational programs and we are happy to discuss the implications of this for future programs within the Department of Agriculture.

For the past two years the USDA has played an active role in the various studies of U.S. civil space programs conducted under the auspices of the Policy Review

Committee (Space). These studies led ultimately to the document entitled "Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options." The Secretary of Agriculture has taken great personal interest in the expansion of research on applications of aerospace technology to agriculture and renewable resources. USDA representatives were active participants in preparing the planning document and the discussion of the issues and options reflects many of the concerns of the Department. We felt it necessary to take an active part in shaping the program because of our role as a major Federal user of remotely sensed data. As I indicated to this Subcommittee in the statement presented earlier this year, the Department of Agriculture uses remotely sensed data in many varied applications, including crop condition assessments, renewable resource inventories, and delineation of crop acreage, to mention only a few. We look forward to the time when our assessment of crop conditions, both domestic and foreign, can be even more effectively augmented by satellite data on a comprehensive basis, thereby enhancing the accuracy, timeliness and reliability of our reports.

In order to better utilize remotely sensed data from space, we are now engaged in an extensive research program to determine best ways to utilize land observing satellite data sources. In my earlier statement I described AgRISTARS (Agricultural and Resource Inventory Surveys Through Aerospace Remote Sensing), which followed an earlier, more limited program called LACIE (Large Area Crop Inventory Experiment). The AgRISTARS program is proceeding through its first year and should provide valuable information on which to judge the utility of space data in the various USDA programs. AgRISTARS is a multi-agency program, with the Departments of Agriculture, Commerce, and Interior, and the Natural Aeronautics and Space Administration joined in a common effort to determine the usefulness, costs, and extent to which aerospace remote sensing technology can be integrated into present and future USDA information systems.

We are also transferring our applications research to operational programs and have used Landsat data on a test basis to revise statewide acreage estimates for specific crops. And we have begun to develop and test techniques for detecting and analyzing crop stress in foreign countries.

For example, throughout the growing season in 1978, we tested methods to detect and measure crop stress to assess the condition of the Soviet Union's wheat crop. The early findings of excellent crop conditions were later confirmed by official USSR reports. Last year, using these and other data, our foreign crop analysts were able to accurately assess the extent and probable impact of winterkill, drought, and hot dry winds on Soviet grain production.

Early this year we began to analyze Landsat and meteorological data for crops and conditions in other countries. I mention these examples as evidence of a pragmatic approach to the use of remotely sensed data. As I have noted in earlier testimony, we want technology shaped to fit our specific needs. The extensive consultation which took place during the drafting of the issues and options enabled USDA, as a data user, to make others aware of our specific needs and information requirements.

In brief, we feel that the issues and options document is an important first step in establishing a national civil operational land remote sensing satellite system. We look forward to a Transition Plan that will be shaped as required to meet the needs of all users and to take account of changing technology and funding situations. We intend to be actively involved in both review and revision of the proposed plans through the Program Board, which has been specified in Presidential Directive 54 as the Federal management mechanism.

From our position as a user, we have little to add to the issues and options document at this time. Our research in AgRISTARS should provide important guidance for the future.

So far as operation of the civil land observing system is concerned, we are pleased that the designated Federal operator, NOAA, has given consideration to the various capabilities and systems characteristics which we feel are necessary to acquire data needed to carry out our missions. We are especially pleased that NOAA is involved as the Federal systems operator because of its long and successful operation of the atmospheric satellites systems.

We are concerned that data will be provided to all users at a fair and reasonable cost. The Department has no objection to payment for data received from the satellite systems. However, we believe that users, particularly the smaller users, should not be excluded from taking advantage of this new source of information by prices that increase too rapidly at too early a stage in the development period of the technology.

Although the plans for an operational system deal with development of new technology only tangentially, the establishment of an operational system has defi-

nite implications for users, implying as it does that various features and components will be standardized. We believe emphasis on research should be continued. An operational system which does not have adequate provision for the incorporation of the latest technology will not have full user support. Continued research is important for two reasons. It will allow us to consider applications and activities not possible with present systems, and it will help us achieve better efficiency with systems we have now.

In conclusion, we feel that the discussion document is balanced in its presentation of the issues and options and provides adequate guidance for an effective land remote sensing program yet is sufficiently flexible to meet changing opportunities.

[The following information was subsequently received for the record:]

QUESTIONS OF THE COMMITTEE AND THE ANSWERS THERETO

Question. Would the transfer of the civil land remote sensing satellite system to the private sector impact the use of satellite remote sensing data in your Department? How?

Answer. Transfer of the civil land remote sensing satellite system to the private sector would have minimal impact on the use of satellite remote sensing data in the Department of Agriculture, provided that the Department's requirements for timeliness, quality, and reasonable cost of data are met, and provided that the Department is given access to all data and that data may be used without restriction.

A major factor in use of satellite data will be cost. If the transfer of the satellite system to the private sector results in the establishment of price levels that are not competitive with existing or alternative sources, for example, aircraft, ground-based systems, or foreign satellite systems, use of satellite data could be sharply curtailed. Restrictions on data use, such as those stemming from copyright laws, could also impact use of satellite data by the Department.

Question. If and when the civil land remote sensing satellite system is transferred to the private sector, it appears the Federal Government will have to provide support during the early years. What is your view as to how the Federal Government should provide such support?

Answer. It is assumed that the Federal Government will continue to support the civil land remote sensing satellite system through research and development of new technology and that this activity will be performed by a Federal agency. The preferred form of Federal support to the private sector for operation of a civil satellite system would be a subsidy covering the difference between cost of operation and receipts from sales of data. The subsidy would be budgeted by the National Oceanic and Atmospheric Administration, the agency now responsible for management of the civil land remote sensing satellite system.

Question. All users agree that continuity of data should be assured, and the President directed (in PD 54) that be a prime objective. However, since both Landsat 2 and Landsat 3 are barely hanging in there, there will almost surely be a data gap. How will that affect your Department?

Answer. A data gap prior to the launch of Landsat D will affect the Department of Agriculture in two major areas: Crop condition assessment activities of the Foreign Agricultural Service and pilot testing planned for AgRISTARS (Agricultural and Resource Inventory Surveys Through Aerospace Remote Sensing—a multiagency research program).

In an effort to reduce the impact of a Landsat data gap on worldwide crop assessments, the Foreign Agricultural Service is now exploring possible use of data from meteorological satellites as a temporary substitute.

Landsat data from previous years can be used productively in many AgRISTARS tasks. However, development, testing, and evaluation of new procedures will be definitely hampered without current data. Length of the data gap will determine the extent of the impact on the research program.

Question. It also seems clear that unless some early planning is done to assure continuity of data following Landsat D' another data gap will occur. Have the agencies made known to the OMB the importance of continuity of data and the importance of early funding for the continuation of data acquisition after Landsat D'?

Answer. The Department of Agriculture has made known its concern about continuity of data, including the possibility of a data gap following Landsat D', during preparation and review of the plan for transfer of responsibility for management of the civil land remote sensing satellite system to the National Oceanic and Atmospheric Administration. This concern has been expressed in the presence of

OMB representatives at meeting on the plan and before OMB examiners in support of Landsat budgets.

Question. If continuity of data is assured, then the timely distribution of that data becomes a critical issue. In what time, after the satellite acquires the data, must it be available to be useful to your Department?

Answer. For "quick look" evaluation, that is, early detection of crop stress or assessment of natural disasters, receipt of data within 24 to 48 hours after acquisition is required.

Question. To provide data to the users within that time, improvements will have to be made to the ground processing system. Have the views of your Department on this issue been made known to the OMB?

Answer. The views of the Department of Agriculture on improvements to the ground processing system are reflected in the specifications for timeliness, quality, and reliability of data indicated in the plan for the transfer of management responsibility of the civil land remote sensing satellite system. The plan is being reviewed by OMB. The Department has made its views known directly to OMB on several occasions, most recently at a briefing given on July 13, 1980, by the Foreign Agricultural Service to assigned OMB examiners.

Question. How good must the spatical, spectral, and radiometric resolution be from the operational land remote sensing satellite system to meet the needs of your Department?

Answer. A definitive answer concerning required spatical, spectral, and radiometric resolution will be forthcoming as research proceeds in the application of data from Landsat and other satellites. Tentatively, based on needs indicated by individual agencies and on preliminary research, it appears that an operational system with a spatial resolution of 10 meters or less will be necessary to satisfy the larger share of departmental requirements. In terms of spectral resolution, interest has been expressed in sensors which have the capability to "filter", or give a narrower band width than is now available with the Multispectral Scanner (MSS). At present, spectral bands available on the MSS and planned for the Thematic Mapper (including the thermal band) meet minimum requirements.

Expansion of remote sensing coverage to a wide variety of crops and cultural practices, and to renewable resource applications, will necessitate resolution sufficiently improved to discriminate between individual crops and forest cover types and to delineate relatively small fields.

Question. How important is spectral and radiometric resolution vis a vis spatial resolution to your Department?

Answer. It is recognized that with present sensor technology improvement of spatial resolution may interfere with improved spectral resolution. Further research is required before the relative importance of spatial and spectral resolution can be determined. At the present time the utility of narrower spectral bands for such applications as determination of crop stress and improved crop identification has not been fully explored.

Question. The transition plan proposes that the spacecraft remote sensing data be separated from the aircraft remote sensing data at the EROS Data Center. Consequently, there will be at least two centers to which users will have to go to review what remote sensing data is available. Congressional proposals have been directed to establishing an earth remote sensing capability that would include all remote sensing data as opposed to having separate systems. What are your views on the proposed separation on these data into two separate and distinct organizations?

Answer. Differences in data format, geographic coverage, and length of record must be considered in justifying separate remote sensing data centers for aircraft and spacecraft. It appears that these criteria have been met. Aircraft remote sensing data will be largely on film; coverage is domestic; archives extend from the 1930's to the present. Spacecraft data will be based on digital tapes; coverage is worldwide; archives will extend from about 1972 to the present.

Separation of spacecraft data from aircraft data could mean more efficient and timelier handling of digital data for real-time users.

Senator STEVENSON. Thank you, sir. Mr. Terrell?

Mr. TERRELL. Thank you, Mr. Chairman. I am pleased to be here this morning. As you suggested, I will summarize my testimony and submit the full testimony for the record.

The Department worked closely with NOAA and NASA in drafting the international sections for discussion document. The Department believes the document is responsive to the needs of the inter-

national community. I will deal with the principal policy highlights and guidelines in the rest of my testimony.

First, the document proposes that foreign ground stations continue to receive data directly from the operational system; that is, directly from the satellite. This will enable foreign users to acquire the data in a timely manner and to process it in accordance with their needs. Second, the document proposes to continue making data from one or more U.S. distribution facilities available to foreign users in a public and nondiscriminatory manner.

These two steps will, in general, provide access to data from the system by international users on the same basis as domestic users. This is the most practical and effective way of adhering to the obligations we undertook in the 1967 outer space treaty, to share the benefits of space as widely as possible.

The pricing policies and the fee structure which will be developed for the operational system will also have important bearing upon its international acceptability. We support the concept of setting prices which will enable NOAA to recover the costs of acquiring and processing land remote sensing data. We believe such prices should be consistent both for domestic users, foreign station operators, and other foreign users so that price increases can be accommodated into their respective planning and budget cycles.

Some form of domestic legislation will be needed to protect the data derived from the system, if we are to have a private operator run the system. Similar protection will be needed abroad, and we have proposed that State and NOAA work together to devise a scheme which will afford that protection.

We support the concept of eventual private ownership and operation of the system, which will introduce private incentive and innovation into remote sensing and encourage the development of new markets both for data and for processed information. The Department is not unmindful, however, that some within the international community will be somewhat suspicious of private involvement in this area. There will almost certainly be those who will argue that this implies that information from developing States will be more readily available to large, private concerns than to the decisionmakers in those countries.

The Department believes that these sorts of suspicions can be effectively dealt with if we continue to make data derived from the operational system available to all users on a public, nondiscriminatory basis, and if data prices are fair and reasonable.

The European Space Agency, France, India, Japan, and the Soviet Union have initiated land remote sensing programs. These foreign programs offer the prospect of both competition and cooperation with the U.S. operational program. The high costs of remote sensing for all operators requires that we avoid duplication in spacecraft and ground systems. This can be achieved by compatibility in future systems, and by taking advantage of the complementarity of the various systems plans. Recognizing these developments, at the U.N. Conference on Science and Technology for Development in 1979, which you attended, the United States proposed cooperation with foreign satellite operators on compatibility and complementarity of remote sensing systems. This intiative at UNSCTD was

followed up by a meeting this May in Ottowa hosted by Canada, in which France, India, Japan, ESA, and the United States participated. The Department strongly supports this approach. My written testimony contains further details on the Ottowa meeting, which you and your staff may be interested in because of your personal involvement in it.

We believe that foreign user requirements, particularly those of developing countries, should be integrated by NOAA, working closely with the State Department and other agencies, and in the upcoming regional meetings with user countries. In Ottowa, it was agreed that France and Canada will organize a regional meeting with users for Africa. Japan and India will take the initiate for a regional meeting for Southeast Asia, and the United States will organize the Latin American regional meeting.

As developed in the document, we view NOAA as the agency to conclude agreements with foreign agencies wishing to receive data directly from the interim and fully operational system, for administering pricing policies, for direct reception, and for continuing the NASA-established land station ground station operations working group.

That concludes my testimony.

[The statement follows:]

STATEMENT OF NORMAN TERRELL, DEPUTY ASSISTANT SECRETARY FOR SCIENCE AND TECHNOLOGY, BUREAU OF OCEANS AND INTERNATIONAL ENVIRONMENTAL AND SCIENTIFIC AFFAIRS, DEPARTMENT OF STATE

Mr. Chairman and members of the committee, I am pleased to appear before you today to present the Department of State's views on the discussion document for a Civil Operational Land Remote Sensing System. We have worked closely with NOAA and other agencies in the preparation of the document, and believe it is an important first step in meeting the Administration's goal of creating an operational system. The objective of the operational program to provide long-term data continuity, at a higher level of service to a wider user community, will be of great benefit to the world community, particularly to developing nations. Careful management of the U.S. program with regard to international aspects of data dissemination policy and pricing policy will increase international cooperation, as well as international participation in the peaceful uses of outer space.

The proposed operational program will be built upon well-established foundations of international cooperation. From the beginning of our experimental land remote sensing program, we have encouraged other governments and international groups to participate with us as active partners in what has, to a large extent, become a common effort to assess the potential of this new scientific tool. Investigators from over 50 countries helped us to assess the usefulness of Landsat data. In addition, agencies in about a dozen foreign countries have made agreements with NASA for the direct reception of data from the current experimental Landsat satellites. These agreements provide for:

a. Foreign funding of the station and its operations.

b. Non-discriminatory public availability of all Landsat data acquired by the station.

c. Data collection for NASA in the event of failure of a subsystem such as the onboard tape recorder.

d. Payment to NASA of an annual fee of $200,000 per station.

These features of the US Landsat program approach have been highly successful. International users rely heavily on Landsat data for not only applications but for education and research. Developing countries, the Agency for International Development and others are continually finding new applications for this unique US contribution to the development process.

The Department of State worked closely with NOAA and NASA in drafting the international sections of the discussion document, and believes the document is responsive to the needs of the international community. It might be useful if I raised some of the international implications of the document with you and indicate

what guidelines we believe should be followed to ensure the widest possible international acceptance and support.

First, the discussion document proposes that foreign ground stations continue to receive data directly from the operational system. This will enable foreign users to acquire data in a timely manner and to process it in accordance with their needs. Second, the document proposes to continue making data from one or more US distribution facilities available to foreign users in a public and non-discriminatory manner.

These two steps will, in general, provide for access to data from the system by international users on the same basis as domestic users. We believe this is the most practical and effective way of adhering to the obligation we undertook in the 1967 Outer Space Treaty to share the benefits of space as widely as possible.

The pricing policies and the fee structure which will be developed for the operational system will also have an important bearing upon its international acceptability. We support the concept of setting prices which will enable NOAA to recover the costs of acquiring and processing land remote sensing data, and we believe such prices should be consistent both for domestic and foreign users. It is essential, however, that price increases be phased in gradually over time so that foreign ground station operators and other foreign users can accommodate the price increases into their respective planning and budgetary cycles.

Some form of domestic legislation will be needed to protect the data derived from the system if we are to have a private operator run the system. Similar protection will be needed abroad as well, and we have proposed that State and NOAA work together to devise a scheme which will afford us that protection.

We also support the concept of eventual private operation of the system, since it will introduce private incentive and innovation into remote sensing and encourage the development of new markets, both for data and processed information. We are not unmindful, however, that some within the international community will be somewhat suspicious of private involvement in an area which produces information about the world's natural resources. There will almost certainly be those who will argue that this implies that information from developing states will be more readily available to large private concerns than to their own decision makers. The Department believes these sorts of suspicions can be effectively rebutted if we continue to make data derived from the operational system available to all users on a public, non-discriminatory basis. In this context, it is essential, as noted, that data prices are fair and reasonable.

The European Space Agency, France, India, Japan and the Soviet Union have initiated land remote sensing programs. These foreign programs offer the prospect of both competition and cooperation with the US operational program. The high costs of remote sensing for all operators requires avoidance of duplication in spacecraft and ground systems. This can be achieved by compatibility in future system developments and by taking advantage of complementarity of the various systems being planned. Recognizing these developments, at the 1979 United Nations Conference on Science and Technology for Development (UNCSTD) the US proposed cooperation with foreign satellite operators on compatibility and complementarity in space remote sensing. The UNCSTD initiative has been followed up by a meeting this May in Ottawa, hosted by Canada, in which France, India, Japan, ESA and the US participated. The Department strongly supports this cooperative approach.

NOAA led the Ottawa meeting and will be the US agency to coordinate with foreign operators of land remote sensing systems in order to increase the utility of foreign satellite data to US users and maximize the effectiveness of US program costs. Agreement in Ottawa covered cooperation in long-range planning, medium-range coordination of operational systems, short-range consultative groups and regional meetings in Africa, Southeast Asia and Latin America between users and system operators. ESA will host the next meeting of the Ottawa participants in February/March of 1981 on long-range plans for 1988 and beyond. France will initiate a meeting this year of countries firmly planning service in land remote sensing in the medium term 1985–87. Short-range consultative groups by other satellite operators will be patterned after the US Landsat Ground Station Operations Working Group. This cooperative activity and the regional meetings can serve toward a focus in remote sensing applications for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space planned for August 1982.

We believe that foreign user requirements, particularly those of developing countries, should be integrated by NOAA working closely with the Department of State, NASA, AID, and other interested US agencies, and in the above-mentioned regional meetings. At Ottawa it was agreed that France and Canada would organize the regional meeting for Africa; Japan and India would take the initiative for the

Southeast Asia Regional Meeting; and the US would organize the Latin American Regional Meeting. As developed in the document, we view NOAA as the agency to conclude agreements with foreign agencies wishing to receive data directly from the Interim and Fully Operational System, for establishing pricing policies for direct reception, and for continuing the NASA-established Landsat Ground Station Operations Working Group.

I hope that I have been able to outline in this brief draft response the varied international issues that exist as the US Land Remote Sensing Program evolves to operational and commercial use.

In conclusion, I would like to state that the Department of State has been gratified with the speed and commitment with which NOAA has been working on the Transition Plan, and we hope the plan can be finalized in the near future. International users rely heavily on Landsat data, and we very much hope the United States can move ahead in a manner which avoids a gap in Landsat data continuity and maintains US leadership in land remote sensing.

[The following information was subsequently received for the record:]

Questions of the Committee and the Answers Thereto

CONTINUITY OF DATA

Question. All users agree that continuity of data should be assured, and the President directed (in PD 54) that be a prime objective. However, since both Landsat 2 and Landsat 3 are barely hanging in there, there will almost surely be a data gap. How will that affect your Department?

Answer. A data gap will have no effect on the Department of State, since the Department does not use the data. It would, however, have a serious adverse impact on international users who rely on information from the system.

Question. It also seems clear that unless some early planning is done to assure continuity of data following Landsat D', another data gap will occur. Have your agencies made known to the OMB the importance of continuity of data and the importance of early funding for the continuation of data acquisition after Landsat D'?

Answer. The Department of State has repeatedly informed OMB of the adverse impact which a data gap would have on international users and stressed the importance of early funding for the continuation of data requisition after Landsat D.

Question. If continuity of data is assured, then the timely distribution of that data becomes a critical issue. In what time, after the satellite acquires the data, must it be available to be useful to your Department?

Answer. The Department of State does not use data from the Landsat program.

Question. To provide data to the users within that time, improvements will have to be made to the ground processing system. Have the views of your Department on this issue been made known to the OMB?

Answer. Yes.

PRIVATE SECTOR OWNERSHIP

Question. Would the transfer of the civil land remote sensing satellite system to the private sector impact the use of satellite remote sensing data in your Department? How?

Answer. The Department of State does not use data from the civil land remote sensing system.

Question. If and when the civil land remote sensing satellite system is transferred to the private sector, it appears the Federal Government will have to provide support during the early years. What is your view as to how the Federal Government should provide such support?

Answer. The Department of State has no preference as to how the Federal Government should support private operation of the civil land remote sensing system.

INTERNATIONAL

Question. What are the international sensitivities with respect to private sector ownership and management of a U.S. civil land remote sensing system?

Answer. International users have raised no specific objections to private sector ownership and management of a U.S. civil land remote sensing system. We believe that private ownership and management will be acceptable to international users as

long as we continue to provide direct readout to foreign ground stations and data from the system to foreign users at reasonable prices.

Question. What is the government's policy with respect to these sensitivities?

Answer. Our policy will be to continue to provide for these.

DATA SEPARATION

Question. The transition plan proposes that the spacecraft remote sensing data be separated from the aircraft remote sensing data at the eros data center. Consequently, there will be at least two centers to which users will have to go to review what remote sensing data is available. Congressional proposals have been directed to establishing an earth remote sensing capability that would include all remote sensing data as opposing to having separate systems. What are your views on the proposed separation on these data into two separate and distinct organizations?

Answer. The Department of State has no views on this question, since it does not use data from the land remote sensing system.

RESOLUTION

Question. How good must the spatial, spectral and radiometric resolution be from the operational land remote sensing satellite system to meet the needs of your department?

Answer. The Department of State does not use data from the land remote sensing system.

Question. How important is spectral and radiometric resolution vis a spatial resolution to your department?

Answer. The issue is not of importance to the Department of State.

Senator STEVENSON. All right. Mr. Jarman.

Mr. JARMAN. Thank you, Mr. Chairman. I have some general comments that represent the overall view of the Department, and also some specific comments that relate to the needs and projected use of the products of the transitional and future operational system, by what we consider the probable principal DOD users, the Army Corps of Engineers and the Defense Mapping Agency.

The Department of Defense has a vital interest in the development and implementation of all satellite remote sensing systems to meet national needs, and we believe that the planning document is an important first step in the transition of the present experimental civil system to an operational status.

DOD, of course, will continue to express its views through the program board membership and other appropriate channels as important issues arise. One issue that we think will need further evaluation as we go into an actual transition is the pricing policy and marketing strategy. The requirements, the private sector role of the systems must be better defined, and Government policy better clarified before we can really make a commitment and a stand on pricing policy.

While the military establishment does not have a major operational involvement in the civil land remote sensing, national security policy concerns do exist within DOD with regard to both the national and international aspects of civil and remote sensing.

These concerns primarily relate to open foreign availability of advanced remote sensing technology and data. Therefore, as the operational systems evolve, we expect to continue our close working relationship with NOAA and the civil community. In recognition of the dual DOD user policy interests and the fact that the Army Corps of Engineers civil works has an administrative and budgetary chain separate from DOD, both the Department of Defense and the Corps of Engineers will be represented on the proposed interagency program board.

If I may, now I'd like to address a few points on the civil system use by the Corps of Engineers. We started participating in the Landsat program in 1972 with the launch of the first resources technology satellite. Prior to that, the Corps of Engineers had depended upon aerial data acquisition systems for many years, and we are dependent upon those systems for planning and design activities as well as regulatory functions.

We made operational use of the existing research satellite fairly early as a result of the requirements posed by Public Law 92-367, the National Dam Inspection Act. Part of that act requires an inventory of dams. Through the use of satellite imagery, we were able to improve our inventory by approximately 10 percent.

We have done quite a bit of research which has convinced us that even the present Landsat system provides the accuracy needed for the commonly used hydrologic models, not only in the corps, but throughout the hydrologic community. We have also developed classification systems that allow us to update grid cell data banks used in regional analyses and environmental studies.

Although the Corps of Engineers has established the usefulness of space-acquired data, the operational use of such data will be constrained until most or all of the issues raised by the discussion document are resolved. The effective use of space-acquired data will require significant technical and procedural changes within the organization. We will have to revise the standard models to take the new format of data, will have to revise the data-handling procedures, the interagency coordination process, and also develop new sources for technical support from private industry.

An assurance of the continuity of data, as well as the institutional framework which permits the coordination of systems changes, will be prerequisites to an operational use of the satellite system.

Now, Mr. Chairman, I will conclude my statement. There is further elaboration submitted for the record.

[The statement follows:]

STATEMENT OF JOHN W. JARMAN, WATER RESOURCES SUPPORT CENTER, U.S. ARMY CORPS OF ENGINEERS

Mr. Chairman and members of the subcommittee, I am Jack Jarman, Water Resources Support Center, U.S. Army Corps of Engineers. I am pleased to represent the Department of Defense at these hearings on the Transition Plan for the Civil Operational Land Remote Sensing from Space. I have some general comments that represent the overall view of the Department of Defense and specific comments that relate to the needs and projected use of the products of the transition system and the future operational system by the probable principal DOD users, the Army Corps of Engineers and the Defense Mapping Agency.

NOAA is to be commended on the document "Planning for a Civil Operational Land Remote Sensing Satelite System: A Discussion of Issues and Options" that addresses a complex public policy area in a coherent manner. The Department of Defense has a vital interest in the development and implementation of all satellite remote sensing systems to meet national needs.

We believe the planning document is an important first step in the transition to operational status. DOD will continue to express its view through its Program Board membership and other appropriate channels on such important issues as "maximum system" consideration, assignment of front-end system costs to user agencies, possible integration of systems into military operations during national emergencies, and the legal aspects of government technology transfer to a private corporation under any form of private ownership or operation.

In considering pricing policy and marketing strategy, it is important to recognize that an agressive pricing policy could present other nations with a significant opportunity to make in-roads into the potential US data market by offering more

attractive terms. Although this issue is discussed in the planning document in a balanced way, it needs to be evaluated further during the actual transition as requirements, private sector role and the systems are better defined and government policy is further clarified.

While the military establishment does not have a major operational involvement in civil land remote sensing, security policy concerns do exist within DOD with regard to both national and international aspects of civil of civil land remote sensing. These concerns primarily relate to open foreign availability of advanced remote sensing technology and data. Therefore, as the operational systems evolve, we expect to continue our close working relationship with NOAA and the civil community. Such coordination is exemplified by previous PD-37, PD-42, and PD-54 policy making activities.

In recognition of dual DOD user and policy interests and the fact that the Corps of Engineers—Civil Works, has an administrative budgetary chain separate from DOD, both the of Defense and the Corps of Engineers will be represented on the Interagency Program Board for Civil Land Remote Sensing responsible for continuing Federal coordination and regulation in the civil operational remote sensing area. Now I will address the use of civil system data by the Corps of Engineers.

The Corps of Engineers has depended upon aerial data acquisition systems for many years. Without such systems our planning and design activities, as well as the performance of the regulatory responsibilities assigned to the Corps of Engineers, would have been severely hampered. The initiation of civil remote sensing from space with the launch of the Earth Resources Technology Satellite (later renamed Landsat) in 1972 provided an opportunity to expand our use of remote sensing techniques into areas which had previously been infeasible or uneconomical. The data communications capabilities on Landsat I provided us with the ability to test the use of satellite data relay for the collection of hydrologic data. These tests have resulted in a rapidly expanding operational use of satellite data relay in our reservoir control and flood management activities. Our use of the imaging capabilities of the Landsat system required a significantly greater amount of research and development before the operational applications could be verified but the digital format of the data, the ability to analyse the data in discrete spectral ranges and the wide area coverage assured the acquisition of information not previsouly available. Our first operational use of the imaging system followed the passage of Public Law 92-367, National Dam Inspection Act. This legislation required on inventory of non-Federal dams having certain minimum dimensions or capacity. Landsat digital data was used to develop map products depicting all water bodies in the contiguous United States having a surface area of ten acres or more. These map products were used in the development and verification of the inventory which contains 60,000 dams. Following this relatively straight-forward use of multispectral classification techniques, the Corps of Engineers expanded testing of these techniques and has determined that Landsat derived land-use classification percentages are well within an acceptable error to be used for hydrologic modeling. Landsat derived land-use classifications also may be used to develop or up-date grid cell data banks to be used in regional analyses. The Corps is now initiating a major demonstration program to facilitate technology transfer within the Corps and in the water resources planning community.

Although Corps of Engineers studies have established the usefullness of space acquired data, the operational use of such data will be constrained until most or all of the issues raised by the discussion document are resolved. Effective use of space acquired data will require significant technical and procedural changes in the Corps. Standard models must be revised, data handling procedures and inter-agency coordination processes implemented or changed, and new sources for technical support from private industry must be developed. An assurance of continuity of data as well as an institutional framework which permits the coordination of system modifications are prerequisites to making these changes.

Mr. Chairman, this concludes my statement. I would be pleased to answer any questions that you may have.

[The following information was subsequently received for the record:]

QUESTIONS TO THE COMMITTEE AND THE ANSWERS THERETO

PRIVATE SECTOR OWNERSHIP

Question. Would the transfer of the civil land remote sensing satellite system to the private sector impact the use of satellite remote sensing data in your department? How?

Answer. DOD and the Corps of Engineers use of data from a civil land remote sensing satellite system will be based on the quality of the data and the economic trade-off between civil satellite remote sensing data acquisition and data acquisition by alternative methods. The only data use impact of a transfer of the civil land satellite remote sensing system from the public to the private sector which might be expected is in the economic evaluation. If private sector management resulted in a significant increase in the cost of the data, a reduction in data use can be anticipated. Since alternate data source exist, the demand for remote sening data is relatively elastic.

Question. If and when the civil land remote sensing satellite system is transferred to the private sector, it appears the Federal government will have to provide support during the early years. What is your view as to how the Federal government should provide such support?

Answer. If and when the civil land remote sensing system is transferred to the private sector, Federal government subsidy for the core system will probably be required. This subsidy can be reduced as the user base broadens but a partial subsidy to support general public benefits will probably be a continuing requirement.

Question. All users agree that continuity of data should be assured, and the President directed (in Pd 54) that be a prime objective. However, since both Landsat 2 and Landsat 3 are barely hanging in there, there will almost surely be a data gap. How will that affect your department?

Answer. DOD and the Corps of Engineers use of Landsat data has been predicted on the probability of a period during which Landsat data is not being acquired. We will merely defer any actions which will create dependency on Landsat type data until continuity is assured.

Question. It also seems clear that unless some early planning is done to assure continuity of data following Landsat D', another data gap will occur. Have your agencies made known to the OMB the importance of continuity of data and the importance of early funding for the continuation of data acquisition after Landsat D'?

Answer. We have not made specific comments to OMB concerning the timing of a Landsat D' launch.

Question. If continuity of data is assured, then the timely distribution of that data becomes a critical issue. In what time, after the satellite acquired the data, must it be available to be useful to your department?

Answer. For routine data requirements, delivery of data to the user within seven days of acquisition, or, in the case of archival data, within seven days of request will be satisfactory. However a significant requirement for availability of data within forty-eight hours of acquisition exists for the Corps of Engineers. This requirement results from a need for data in emergencies, such as floods or severe icing conditions, as well as a need to monitor conditions, such as extent of snow, surface water, saturated or frozen soil in runoff areas, which might result in our contribute to emergency situations.

Question. To provide data to the users within that time, improvements will have to be made to the ground processing system. Have the views of your department on this issue been made known to OMB?

Answer. Improvements to the ground processing system to satisfy our requirements for timely distribution of data could not be justified for an experimental system. Our requirements were submitted to the Interim Policy Group on Land Remote Sensing during the development of the document entitled "Planning for a Civil Operational Land Remote Sensing System: A discussion of issues and options."

Question. How good must the spatial, spectral and radiometric resolution be from the operational land remote sensing satellite system to meet the needs of your department?

Answer. A ten meter spatial resolution system would satisfy virtually all of the DOD/CE requirements for data from the civil system. A reduction to a thirty meter system would eliminate approximately 25 percent of our potential uses. Generally we have found that the spectral and radiometric resolutions of the MSS satisfy most of our needs. We do have potential uses in the emitted thermal spectral ranges and possibly in slightly lower spectral ranges to improve water penetration capability.

Question. How important are spectral and radiometric resolutions vis a vis spatial resolution to your Department?

Answer. Spectral and radiometric resolutions are at least as important as spatial resolution. I believe that this will be true for all users who stress digital analysis.

DATA SEPARATION

Question. The transition plan proposes that the spacecraft remote sensing data be separated from the aircraft remote sensing data at the Eros Data Center. Consequently, there will be at least two centers to which users will have to go to review what remote sensing data is available. Congressional proposals have been directed to establishing an earth remote sensing capability that would include all remote sensing data as opposed to having separate systems. What are your views on the proposed separation on these data into two separate and distinct organizations?

Answer. If adequate search and retrieval systems are developed and maintained, the archiving of spacecraft and aircraft remote sensing data at different locations should not have a significant adverse impact on the utility of the data.

Senator STEVENSON. Thank you, sir. Your statement will be entered into the record, too.

Well, I think the principal subject that I'd like to examine with you is private sector participation. Mr. Terrell, to what extent are foreign countries or collections of them, such as ESA, planning for private sector operation or ownership of remote sensing systems?

Mr. TERRELL. I have no information that would indicate that they are. To my knowledge, they would operate as Government or international organization entities.

Senator STEVENSON. Do you think it's an overstatement for me to say that in no other country would this debate even take place?

Mr. TERRELL. Excuse me, I didn't hear the last words.

Senator STEVENSON. I'm suggesting that in no other country in the world would this debate about private or public sector participation even be heard.

Mr. TERRELL. You're a better judge of that than I am.

Senator STEVENSON. No, you're with the Department of State; but I've been around this world quite a few times debating remote sensing.

Mr. TERRELL. Yes, sir.

Senator STEVENSON. I guess my conclusion is that it's just premature to make that decision about the role of the private sector. But for ideological, if not practical, reasons, we may make it, especially in the next administration, depending a little on the outcome of this election.

You said other countries would be somewhat suspicious. Don't you think that that's somewhat of an understatement?

Mr. TERRELL. I think that how that will be manifested will depend on how we operate the system. I think that if we operate the system in a way that provides direct readout to foreign stations, if the prices are raised in a reasonable way taking into account the needs of the other countries and their economic means, if we continue to make the data available in a nondiscriminatory way and if we make some provision for the needs of developing countries, then I think how the system is operated, whether it is operated privately or publicly will not be the issue.

The concern, I guess, would be if in turning it over to the private operator we change these policies.

Senator STEVENSON. You what?

Mr. TERRELL. If we change these policies, which I think are essential, in the course of turning the system over to a private operator, then I think the concerns that would be associated with private ownership would be very considerable indeed.

On the other hand, if we change those policies for any reason, even if the system were operated by the Government, the same concerns would arise.

Senator STEVENSON. You say the data should be made available, I think you said, on a public and nondiscriminatory basis.

Mr. TERRELL. Yes, sir.

Senator STEVENSON. Let's reduce this to concrete cases. Does that mean that data collected by a privately operated and managed remote sensing system on Peru——

Mr. TERRELL. By a Japanese system.

Senator STEVENSON [continuing]. By Hughes Aircraft system or an Exxon system, will be made available on a nondiscriminatory basis to Chile?

Mr. TERRELL. Yes, I believe that should be the policy.

Senator STEVENSON. And you don't think that will create suspicions in Peru?

Mr. TERRELL. At the moment, this has not proved to be a very serious problem.

Senator STEVENSON. At the moment. I should perhaps have prefaced this by suggesting that you do what we, in this country seem to be incapable of doing: peering into the future. Right now we don't have an operational remote sensing system. Ten years from now there may be a problem. Right now, as a matter of fact, there are suspicions right now.

Mr. TERRELL. That's correct.

Senator STEVENSON. Ten years from now when we're operating——

Mr. TERRELL. I think the point I would make is that I don't believe that the concerns that we're going to face are going to be a function of private operation. I believe they're going to be a function of the policies that the United States has on data dissemination. As for the kind of concerns that you're talking about, I don't know where they'll stand in 10 years. I think they will still be with us, but if we are wise we can manage them properly, and I think that we can have the same rules for a private U.S. operator as we have for a Government operator.

Senator STEVENSON. You're saying, essentially a private sector operation with a lot of regulation.

Mr. TERRELL. Yes, sir, from the international standpoint I think that's going to be necessary.

Senator STEVENSON. If anybody else has any reactions to any of these questions, I'd be grateful for them. One of the things most difficult to predict is the evolution of technology. A few years ago, no one would have predicted where we are with respect to space technology and where we are today.

And there aren't many people in the United States who have access to information about the most advanced space technology, because it's on the black side and it's developing very rapidly and impressively, and with applications on the civil side that frequently are not exploited, not used. The technologies are classified. They're going to be far more sophisticated 10 years from now than they are today. Those which are the most sophisticated will remain classified, they will continue to remain classified. And for other reasons, the products of these technologies will be classified also.

Already, we have warehoused a great deal of information that is classified. Yet it has some civil application.

How will private ownership and management affect our ability to utilize the most advanced technologies and the products of that technology 10 years from now? Has that been considered?

Mr. JARMAN. Sir, I believe that the classified technology will probably always lead the field.

Senator STEVENSON. Always what?

Mr. JARMAN. Lead the field. And we will have to be careful in how those technologies are transferred. But there are provisions now for transferring the technologies, and I think that they would continue. I think most people at this table could predict what the operational system would be 10 years from now.

Senator STEVENSON. They could?

Mr. JARMAN. They could, because I believe the technologies are here. It's going to take us 10 years to develop and launch the operational system, and we will be working with today's technologies.

Senator STEVENSON. Well, the scientists that we talked to on the Intelligence Committee feel that the advanced technology should be developed for multiple purposes, at least those that I've talked to. This is a highly respected group of scientists. We're not doing that.

I don't know enough about your user requirements to be very confident of all of this—I'm told that much of the capability that is being developed on the military and intelligence side does have civil applications. I have seen some of it used to produce information for one purpose, but it could be used for other purposes.

Some of this technology is in place now, and there's a lot more coming on stream. What I'm trying to get at is whether we are going to be unnecessarily hindered from integrating technologies and using products that are classified as a result of private sector ownership.

Now, some of the companies know exactly what's going on. They know more about the technology in development than you probably do. But will they be able to use it, if they're operating a remote sensing system, to the same extent a government could, degrading where necessary?

Mr. JARMAN. I believe we'll have to continue the Government regulation on the technology, and it is going to require proper review of transferring. But it appears to me that the procedures are established now, that the private industry, as you say, is aware of the technology and is able to exploit it.

Senator STEVENSON. Certain of the companies in private industry. But not private industry generally. Are we going to confine this operation and maintenance just to those who are already aware?

Mr. JARMAN. I'm afraid I can't see 10 years down the road on what companies will be aware at that time.

Senator SCHMITT. Would the Senator yield for a followup?

Senator STEVENSON. I'll yield you the floor temporarily.

Senator SCHMITT. Following up on Senator Stevenson's line of questioning, I believe what you've said, Mr. Jarman, is that there is a world of classified technology and information right now, and

that for that to be used in the public sector for private, state or commercial use, and whether that is done by a government or a private entity, that classified technology and/or data has to go through some kind of a filtering mechanism; and that filtering mechanism could be created, if it doesn't exist today, to be more or less insensitive of what flows out the other end, whether it goes to a government-run entity or to a private-run entity. Is that correct?

Mr. JARMAN. Yes.

Senator SCHMITT. The real issue, I think, that Senator Stevenson has raised is, do we have an adequate system, as you call it, filter, that lets all the information and/or technology through that could be used for other purposes, nonclassified——

Senator STEVENSON. If I may interject, the problem is it isn't a filter; it becomes a block.

Senator SCHMITT. Well, that's what I mean. I think it's largely a block now. A few things leak through.

I agree with the Senator that it is my impression that a well-conceived filtering system doesn't have to be a block. It can be a great boon to what is done out of the private sector without compromising what is going on in the classified sector.

Mr. JARMAN. Well, Senator, I believe that the technology is being transferred. The information is the thing that is possibly being blocked. I believe the private sector——

Senator SCHMITT. That's the critical thing, the information. One reason it is people say, well, if they have the information, then they know what the technology is to get it. And I understand that. But that doesn't mean that you can't efficiently reach decisions within that filtering system.

Mr. JARMAN. That's correct, sir.

Senator SCHMITT. But there's other stuff right now being blocked that wouldn't give away the store.

Mr. JARMAN. Again, sir, that is policy and I'm not equipped to——

Senator SCHMITT. I'm not asking you to make policy or even to criticize it. We're just trying to search here and make sure we understand the kind of infrastructure that would be required, whether it is a private sector operating system or, in NOAA, a government sector operating system.

Mr. JARMAN. Our position is that the private sector could probably operate the system, given the same type of controls that we have now. And I can't comment on the controls that we have now and whether they are valid in the way the information flows. But we feel that the private sector could operate.

Senator SCHMITT. So you're saying, however we may decide to operate the operational system, whether private or government, we still need to make sure that that filtering mechanism is operating efficiently and adequately, both in protecting the national interest in terms of classified information and in protecting the national interest in terms of making sure that information and technology is available where it can be?

Mr. JARMAN. Yes, sir.

Senator SCHMITT. Mr. Terrell, some years ago, working with one of your predecessors and a number of other individuals, both in the State Department and in NOAA and in NASA, I made an attempt

to get this country—this was in 1973 or 1974—to begin to articulate the grand design for the use of remotely gathered information and communications as a basis for at least a partial new policy towards the developing world.

And in that year of effort, it became clear there was great resistance in the State Department to any new ideas and any new movement in this direction. Is that resistance still there?

I haven't gone inside the bowels of the State Department on this issue for 6 years now. We fell flat on our face. We were aiming towards the Nairobi Conference of UNEP for an articulation of this grand design, which I still feel is a key to foreign policy initiatives beyond anything we are doing in technical or scientific areas with respect to building good, strong relationships in the developing world.

But at that time it was impossible to move it beyond about the Deputy Assistant Secretary level. Is it possible these days to get those kinds of policy initiatives up to a higher level?

Mr. TERRELL. I don't know the specific initiatives you're talking about, Senator, but we are very interested in making sure that remote sensing is of benefit to our policies toward the developing world. I think the Department would be responsive to any ideas in this area.

Senator SCHMITT. Do you see the policy of the State Department to encourage the transfer of technology or the availability of the benefits of technology?

Mr. TERRELL. I think the availability of the benefits of the technology in the remote sensing area is the basic thing that we are most interested in.

Senator SCHMITT. What kind of efforts, generally, in the average developing nation? What kind of efforts or structure do we have, does the State Department have, that encourages these countries to develop the cadre of expertise and ground capability to utilize information gathered remotely?

And when I say that, I'm talking about a very broad base of information, including even ATS-type activities, that involve the dissemination of information to remote areas.

Mr. TERRELL. There are a number of AID programs in both remote sensing and the rural telecommunications area that are oriented toward the problems that you mentioned. In addition to that, we try to keep a general purview over the policies of data dissemination from the NASA system and from the NOAA system as it comes on line to assure that that data is available to the developing countries.

AID also has programs in the area of assisting the training of people in the use of remote sensing data in the developing countries.

Senator SCHMITT. What's the scope of these things? I realize NOAA's been around for a long time, but when I was traveling in countries like Senegal or Nigeria or on into Southeast Asia, India, Pakistan, or Latin America, you never could find much real activity.

Take Nigeria, for example. There was no indication of coordinated effort or even an offer to the Nigerians in 1973 that we would be willing to set up with them a broad-scale educational program, a

broad-scale infrastructure development program, even utilizing what would become surplus telecommunications systems that we have in this country as we replaced them with more modern systems. I never saw any evidence of that.

If there ever was a country of an estimated, what, 80 million people now or more, Nigeria, with remote village locations and I think still a willingness to build an educational infrastructure in the three major national university systems, we should have had fruitful ground in those days. But it didn't seem to exist.

Does it exist today, those kinds of coordinated programs?

Mr. TERRELL. That's a difficult question for me to answer. I think that the degree of coordination and intensity that you're projecting there does not exist in most countries.

On the other hand, to balance that, I think there's genuine effort in our foreign assistance program to devote attention to those problems. There is a competition for resources, though. And there is also a philosophical matter in the foreign assistance program, which you're familiar with, about what you should spend foreign assistance money on; whether it should be for the more immediate needs of the poor or for the development of an infrastructure.

Senator SCHMITT. Let's look at it slightly differently. I picked Nigeria because right now they have a very sizable cash flow as the result of oil revenues. Would the State Department ever consider encouraging contractual relationships between the Nigerian Government and, let's say, some telecommunications entity in this country to develop that infrastructure on some kind of a cost-plus, incentive fee or a barter relationship, or anything that would not represent any direct cost to the American taxpayer, but would have the very rapid effect of providing an infrastructure for that country?

Mr. TERRELL. We definitely would be interested in facilitating that sort of thing. We're also interested in providing services by U.S. Government agencies to Nigeria on a reimbursable basis, so it won't have a cash impact on the budget. This is more broadly available than the grant foreign assistance that I was discussing before.

And for Nigeria in particular, we are exploring in quite a large number of areas the possibility of U.S. Government agencies offering more assistance to Nigeria on a reimburseable basis.

So the short answer to your question is, yes, we would be very interested in seeing the Nigerians acquire more of this capability.

Senator SCHMITT. OK. I will take that as a general philosophical way that you're interested. I'm aware of what use the Department of Agriculture and the Department of the Interior would like to put remote sensing to in this country, not the least of which, I hope, is the evaluation of public lands which at the present time are not accessible to mineral and energy development and to the better prediction of rural agricultural markets.

However, this will be a general question and my last question before I give you back to the chairman: Do you all feel that the plan that the administration has put forward is going to provide you in a timely way with the information that you need in order to do the jobs you'd all like to do?

Mr. TERRELL. Just answering for international concerns, I think that the general answer is yes. I believe that there are some legitimate concerns from the international standpoint about data gaps between the present systems and the operational system, and there's some concern from the international standpoint about upgraded data and improved sensors.

Senator SCHMITT. Mr. Hjort—I love his name. I saw a hjort in Norway when I was doing geology. It's a fascinating animal.

Mr. HJORT. That is what the name means, that's for sure.

I believe that the plan that has been developed has the potential to satisfy our uses. AgRISTARS effort that we have underway is designed to provide information that will help sharpen any plan that we go forward with. And much of that is designed to facilitate our carrying out the responsibility of monitoring and assessing and reporting on world food and agriculture conditions, situations and outlook.

And so through that effort we are working with several other countries of the world in doing so. The system, the civil system, is going to provide some of the information we need. At the present time, in carrying out our responsibilities, we rely not only on the civil system to some degree, but also on classified systems. And I suspect that we will need to continue to do so.

Under this plan, it brings us back in a way to part of what the two of you were addressing earlier, and it was part of my reason for stating in the testimony that we believe there needs to be a strong research component geared to technology and technology transfer from one system to the other.

Senator SCHMITT. Well, as I understand from having been deeply involved in the AgRISTARS effort last year, with the administration plan and the funding levels requested, there's no way that that effort can reach the goals and realize the potential that you already see for it in terms of the availability of information from the civil sector. Is that correct?

Mr. HJORT. Without continuing research to transfer technology that does provide high resolution and so on, there are considerable portions of our needs that cannot be satisfied.

Senator SCHMITT. And in terms of repetitive coverage too, right?

Mr. HJORT. Yes, indeed. If we look at where we are today as opposed to where this plan proposes to take us, we have some rather considerable concerns right now over continuity of data. The quality of the information that we're receiving right now is not good, and we are concerned—and we've talked about this matter before—about the continuity of the information, even for our limited crop assessment program that we have underway, as well as some of our experiments that are called for under AgRISTARS.

Senator SCHMITT. Ms. Davenport, a few years ago I interviewed for the job that you now have, and I think I understand some of the responsibilities of your organization. Needless to say, they didn't give me the job. So apparently I didn't understand it well enough, and I had to retire to the Senate.

Remote sensing provides a great tool for your agency, for your group, and I'm sure you testified to that effect.

Do you feel that under the administration's plan, that the goals can be achieved?

Ms. DAVENPORT. Well, Mr. Chairman and Senator Schmitt, we feel strongly that the administration's plan is the necessary first step.

We at Interior are in a bit of a different position than our colleagues in Agriculture and other agencies. We have been actively pursuing operational use of data from satellites. We feel that the proposals in the interim plan would assure continuity of data, and also would help to address some of the quality problems which we have been having with our current imagery.

As you know, the U.S. Geological Survey has been exploring methods, both imagery and other methods, for trying to locate hidden ore bodies from the surface. We would expect that effort to continue and that the satellite data could be used with other sorts of ground truth to improve interpretations.

Senator SCHMITT. Do you consider that methodology there appropriate, considering we are 45 percent dependent on imports for crude oil and 65 percent dependent on imports for strategic minerals?

Ms. DAVENPORT. Well, Senator Schmitt, we don't have—there's more promise, I believe, in developing a methodology for superficial discovery of hard minerals. At this point, even with the most sophisticated seismic and other data, determining whether hydrocarbons exist or not still is a pretty iffy situation until an area is drilled.

However, we feel that for this decade what has been presented in the transition plan is absolutely necessary.

Senator SCHMITT. But is it adequate, considering the level of need that this country faces? That's all I'm asking.

Ms. DAVENPORT. For the stage at which we are now, it is adequate. But the Interior reviews remote sensing from two points of view: One is the use of the tested and reliable sensors that we have been using for years, and upgrading those; the other is the experimental part of the program which will lead to better capabilities. We support both.

We feel strongly that a guarantee of continued data in forms compatible with those we have been using is very important, both for our uses and for, if you will, the continued viability of the system. Because certainly we're dealing with an involved technology here, and the use of that technology by the private sector is going to be dependent to a great extent on the guarantee of its availability because of the investment and expenditures needed to utilize the system.

So to answer your question, yes, we believe what is proposed is adequate. We don't see the proposal as solidifying or casting in concrete the technology. We expect that we will go forward with technology development, but we want a reliable system that we can use throughout this decade. And we believe that that system is reflected in the options presented in the NOAA document.

Senator SCHMITT. You are more sanguine than I about the depth of our energy and minerals crisis in terms of imports; and also more pessimistic than I about what motivated young men and women can do if they have the technology and information available to use remote sensing in conjunction with other tools to evaluate the mineral and energy resource potential of this country.

particularly public lands that currently are inaccessible to commercial enterprise.

We are on the verge, over the next couple of years, of locking up hundreds of millions of acres of public land relative to mineral exploration, and I should hope that the Government will not stop looking at those lands, in the event that somehow or other than 45 percent or 65 percent or major proportions of it cease to be available to us, because we're then going to have to go find some if we're going to survive as a nation.

I appreciate your testimony and I appreciate the position that you're in as part of the administration. But I just don't think that the administration is being realistic, either in what the depth of our crisis is and what the potential of these techniques may be in the future.

Mr. Jarman, would you care to complete this discussion on how you feel about the plan in terms of the need that you forecast for your agency?

Mr. JARMAN. Senator, I agree with Ms. Davenport that it's an excellent first step. But I think we have a lot of work to do in the next couple of years to come up with an effective operational system in the 1990 time frame.

Senator SCHMITT. Does continuity of data bother you?

Mr. JARMAN. Continuity of data is a critical issue, and I believe that the corps has been very slow in implementing remote sensing systems because of uncertainty about continuity. You can't make the commitment of resources and the conversion of systems required to use this type of data without some assurance that the continuity of data will be there.

Another major problem as far as the corps is concerned is the availability of data in a timely fashion. An operational system will have to provide data rapidly and in a useable form before the major agencies can make commitments to using this type of data.

Senator SCHMITT. And you're thinking largely in terms of flood potential activities?

Mr. JARMAN. Flood potential, yes.

Senator SCHMITT. As a short time frame?

Mr. JARMAN. Yes. I believe that there is need for an accelerated research effort in the 1981 through 1984 time frame to get anywhere near an operational system for the 1990's. And that research is not only going to have to be on the sensor systems, but also on the data utilization and data classification techniques.

There are many management problems in converting to this type of data from the standard point source type data collection. I think that that is going to be a general requirement for all of the agencies and private industry.

Senator SCHMITT. Thank you.

Thank you, Mr. Chairman.

Senator STEVENSON. Mr. Terrell, do you expect that the data from the foreign remote sensing systems will be made available on a public nondiscriminatory basis?

Mr. TERRELL. With the exception of the Soviet Union, that is the indication that we have been receiving. That was also more or less the basis for the discussions in Ottawa. So, absent evidence to the contrary, I would say yes.

Senator STEVENSON. Mr. Jarman, in your statement you referred to concerns within DOD with regard to both national and international aspects of civil land remote sensing. You said these concerns primarily relate to open foreign availability of advanced remote sensing technology and data.

Could you elaborate?

Mr. JARMAN. Sir, that refers back to our previous discussion. We believe that the intelligence community and the Department of Defense will necessarily have to participate in the decisions on the release of both the technology and the data from the systems. But again, we feel that the existing systems are functioning properly, and that we would not suggest that those existing systems necessarily change.

Senator STEVENSON. Mr. Terrell has expressed similar concerns from the Department of State.

Industry witnesses recommend that NOAA aggregate the Federal Government's requirements for remote sensing data, establish the total cost of obtaining such data by means of a Government-owned system such as the interim operational system, make the data requirements and cost estimates available, and then invite proposals from the private sector to meet the defined requirements.

Presumably, this would provide interested companies with the opportunity to reduce the cost to the Government—at least that's the theory—and guarantee the initial market necessary for private sector ownership and operation. They argue that this would provide the needed incentive for the private sector to develop markets, as well as the incentive to invest in the system.

My question is to all of you: Is it possible to define and publicly identify all the Government's remote sensing satellite requirements and estimated costs for such a system that would provide the data to meet those requirements?

Mr. JARMAN. Senator, it's my opinion that the Federal Government's requirements are evolving. We're learning how to use the data now, and it would be extremely difficult to provide industry with a forecast of what our requirements might be 5 or 6 years from now. I wish I could say that it was possible to sit back and say, the Corps of Engineers will need so much of a certain type of data 5 and 10 years from now; but I don't believe that that can be done.

Senator STEVENSON. Mr. Terrell?

Mr. TERRELL. The Department is not a user, so I don't have an institutional view on that.

Senator STEVENSON. Mr. Hjort?

Mr. HJORT. We have conducted a reasonably thorough search through the Department on the data needs, remote sensed data needs, and have tried to classify them. At any portion in time a certain portion of them are satisfied by aircraft and a certain portion by space satellite-based information.

I believe we have a reasonably good fix on the total requirements now. But we certainly don't have the basis yet of being able to quantify the costs and benefits of alternative technologies. That's a main purpose of this AgRISTARS effort, is to assess the effectiveness, cost effectiveness of this technology as opposed to the other

and current technologies that we're using at the present time to obtain these data.

So we're kind of in that state of uncertainty, with not being able to fully comply with the suggestion you've made.

Senator STEVENSON. Ms. Davenport?

Ms. DAVENPORT. Mr. Chairman, I would concur with Mr. Jarman's remarks. We certainly could give a snapshot of what uses our Bureaus are making of these data today. However, through Sioux Falls, we bring together various scientists who define their needs, who experiment with both Landsat data and aerial remote sense data, and it's true, through this interaction of scientists and managers that we make our decisions as to which forms of data we use on a regular basis. So it would be extremely difficult for us to project what our needs would be in, say, 5 or 6 years.

Senator STEVENSON. Thank you. We have a few additional questions which I think I'll submit to you in writing for the record.

Our next witnesses are the Hon. Thomas J. Anderson, assistant majority floor leader of the Michigan House of Representatives and a member of the Natural Resource Information Systems Task Force of the National Conference of State Legislatures and Mr. Leonard Slosky, assistant to the Governor of Colorado for science and technology. He is representing the National Governors Conference.

I'll invite you gentlemen also to summarize if possible your statements. In each case, the full statements will be entered in the record.

Mr. Anderson, please introduce your colleagues for the record.

STATEMENTS OF HON. THOMAS J. ANDERSON, ASSISTANT MAJORITY FLOOR LEADER, MICHIGAN HOUSE OF REPRESENTATIVES AND MEMBER, NATURAL RESOURCE INFORMATION SYSTEMS TASK FORCE, NATIONAL CONFERENCE OF STATE LEGISLATURES; AND LEONARD C. SLOSKY, ASSISTANT TO THE GOVERNOR FOR SCIENCE AND TECHNOLOGY, OFFICE OF THE GOVERNOR, DENVER, COLO., ON BEHALF OF THE NATIONAL GOVERNORS CONFERENCE, ACCOMPANIED BY BRUCE Q. RADO, SUPERVISOR FOR RESOURCE ASSESSMENT PROGRAMS, GEORGIA DEPARTMENT OF NATURAL RESOURCES, ATLANTA, GA.

Mr. ANDERSON. Thank you, Mr. Chairman. I'm very pleased to be here.

My name is Tom Anderson. I'm a member of the Michigan House of Representatives and served as chairman for the Committee for Conservation, Environment, and Recreation as well as chairman of the Joint Committee on Science and Technology of the Michigan Legislature and the Joint Committee on Administrative Rules. But I'm here today representing the National Conference of State Legislatures, an organization which serves all of our Nation's State legislatures and the NCSL Natural Resource Information Systems Task Force, which represents the interests of the States regarding satellite remote sensing and information system technology for use in natural resource policy making.

I also serve as a member of NCSL's State-Federal Assembly, which in 1979 adopted a policy position supporting the Earth Data

and Information Service Act, S. 663, for establishing an operational Landsat system. As a member of the Natural Resources and Environmental Task Force of ISETAP and of the Regional Applications Committee of the Space Applications Board, I have testified before your subcommittee in the past and have long been active in pursuing State and local interests regarding Landsat technology.

Today, though, I speak on behalf of NCSL, Mr. Chairman, and wish to make a statement about the transition plan for operational remote sensing systems.

I'm not the first person who has represented the State legislatures in the area of satellite remote sensing to your subcommittee. In 1977, Representative Chris Spirou of New Hampshire, house minority leader and member of NCSL's first Remote Sensing Task Force, presented testimony regarding S. 657 of that year to you.

Last year, Representative Monroe Flinn, majority whip of the Illinois House, presented NCSL's views on both S. 663 and S. 875, as you recall. Their statements reflect ongoing efforts by the States to insure that their perspectives on Landsat are considered and acted upon.

In November 1979, as we all know, Presidential Directive NSC-54 designated the National Oceanic and Atmospheric Administration as the lead agency for developing an operational land remote sensing satellite system and thereby acknowledged the need for a system which could continuously inventory, monitor, and evaluate our Nation's resources and environment. We commend NOAA for its efforts to develop a plan for carrying out the Presidential directive that is responsive to the needs of Federal, State, and local agencies.

It concerns me, though, that some of our needs have not yet been adequately considered. In April, the NCSL Natural Resource Information Systems Task Force met jointly with the Earth Resources Data Council of the National Governors' Association to discuss NOAA's transition plan. The resulting recommendations pinpoint those issues that we felt needed further attention by the Interagency Policy Group responsible for preparing this plan. These recommendations were later endorsed by ISETAP. A copy of the formal joint recommendations of these organizations is attached to my written statement which I submitted earlier.

Of major concern to our constituents today, as it has been in the past, is technology transfer. This concern relates to the need for Federal assistance in the development of user capabilities to process and apply satellite data. States, unlike many Federal agencies, have traditionally not had the resources to undertake research and development activities.

Moreover, Mr. Chairman, primarily because of budget restrictions, they are sometimes slow in adopting new ways, especially when it comes to newfangled techniques. Therefore, it is especially crucial that State and local governments have the opportunity to benefit from this important, federally developed technology.

An effective Landsat system recognizes the significant role of the States in resource management and nurtures their interests in developing a solid data base as a matter of public policy. A comprehensive technology transfer program would help States develop

their capacity to analyze and apply Landsat data to their particular resource management problems.

An effective program, then, should include orientation, hands-on training, demonstrations, involvement of policymakers who will use Landsat technology in decisionmaking, and systems development assistance for State and local capabilities.

A good case in point, Mr. Chairman, is my own State, just this week embarking upon a comprehensive natural resources inventory as the result of a bill passed earlier this year. The regional remote sensing application program, RAP, initiated by NASA in 1977, recognizes the crying need for State and local government entities to learn to apply Landsat technology. The three NASA field installations which implement this program, each covering a specific geographical area of the United States, use a variety of techniques to acquaint prospective and current users with developments in the remote sensing field.

Cooperative demonstrations of how Landsat technology may be applied to specific user needs are a key part of these programs. Cooperative projects of this kind give users a chance to decide on the basis of first hand experience the extent to which remote sensing data can contribute to their specific informational needs.

If the user decides to build an independent capability to use Landsat data, NASA provides followon assistance for incorporating the technology into the user agency's data system. For example, in the region serving the Western States, NASA has helped develop 13 operational digital processing capabilities in eight States. In the East, NASA has helped develop capabilities in 6 States, and in the region serving the South, 10 States have an operational system, housed either at a university or state agency.

In the short term of 3 years, we have seen the number of States operationally using Landsat data rise from 5 to 24, largely as a result of the NASA regional applications program. Again, my own State is a case in point, where satellite-derived information has not only improved the quality of the work done but allowed it at a reduced cost in both time and budget.

As an aside, I'd like to commend the efforts of this subcommittee to defend the fiscal year 1981 budget of the regional applications Program. We know it is a difficult defense. At the height of the spring budget-cutting fever, the administration had proposed cutting the technology transfer budget of NASA from $12.5 to $7.5 million, and the RAP budget which is included from $4.1 to $1.8 million. This would have been a disaster for those States just embarking on the program.

These cuts would have had a serious impact on NASA's ability to work with these States and local governments on demonstration projects. NCSL is most pleased that the subcommittee raised the authorization level for technology transfer to $10 million.

We again want to commend the committee for their well-done effort. Surely the success of these programs reinforces the need for ongoing technology transfer. Without the involvement of programs like RAP, it is highly unlikely that those States could have developed in-house capabilities to the extent they have, nor is it likely that the appropriate institutional climate would have evolved as

rapidly as it has in many of the States without the presence of a catalyst such as RAP.

Unfortunately, many states have not yet had an opportunity to participate in these programs, and it would therefore be extremely shortsighted to abandon them in midstream. Yet I feel that the Federal Government is heel dragging. Many technology transfer functions are being delegated to the private sector, and although I strongly support the involvement of that sector in providing value-added services, I am not altogether convinced that it is to the States benefits to rely upon private consultants for developing their Landsat and natural resource information systems capabilities.

All routine State Landsat users have to date developed in-house processing capabilities. The Federal Government must surely assume much of the responsibility for the technology transfer task, because it is the Federal Government that truly has the interests of the States at heart. They have no need to develop a clientele of dependent users, which is what the private sector must do in order to profit.

The issue of how the transfer of technology is accomplished in the future is a top priority from the standpoint of the States. The fact is, if we don't have the capability to use Landsat, its value is significantly reduced, and without Federal assistance, the process for developing this State capability will be greatly delayed, I feel, for several years at least.

There are some other matters, in addition to this capability assistance, that need to be resolved to the mutual satisfaction of the many user groups concerned. Because of the limited time, I'll just review a few of the major points quickly. They are elaborated on in the technical index which is attached to our testimony.

One of the most important of our remaining concerns is representation on the program board for the transition. It is my understanding that the transition plan does not provide for the involvement of the National Conference of State Legislatures and the National Governors' Association in the program board as required by the Presidential directive, because the States are partners with the Federal Government and share major responsibilities for resource management. We feel we should be represented on this program board, at least in an ex officio capacity.

There has been a suggestion that we settle for membership on the General User Advisory Committee. However, we feel strongly that our membership would not fulfill the intent of the President's decision if it was restricted to the User Advisory Committee, nor would it adequately serve the interests of the States.

Another problem area pertains to NOAA's goal of developing a self-supporting system. The States feel that the price of the data should be limited to the cost of its reproduction and handling and distribution. Otherwise, it's likely that some State and local government entities may be completely priced out of the market. It should be a matter of public policy for the Federal Government to encourage the use of substantive timely data in natural resources policymaking. A corollary to this recommendation is the need for States to be able to reproduce land remote sensing data for their internal use.

The need for data continuity, Mr. Chairman, is critical as was brought out in previous discussions because a data gap would severely hinder the activities of operational facilities. The impact would probably be most disastrous if a gap occurred during the growing season. Every effort must be made to prevent this.

The States have also expressed their needs with respect to the frequency of satellite observation, recommending that there always be two observing satellites in orbit to provide routine 8-day coverage.

Minimum performance standards for the ground systems have also been specified. Those standards would insure that routine products be delivered to users within 7 to 14 days of satellite observation and that selected data be delivered within 24 to 48 hours for emergency situations which might arise in cases such as flooding or other catastrophic events.

Finally, Mr. Chairman, the States are concerned that historical Landsat data may be destroyed. They therefore have recommended that all land remote sensing data should be kept in archives forever or, at a minimum, the highest quality data for each scene from each season should be kept.

Each of these concerns I have outlined and several others of a more technical nature are more fully detailed in the attached copy of the joint recommendations of NCSL's task force and NGA's Earth Resources Data Council.

On behalf of the National Conference of State Legislatures and the Natural Resource Information Systems Task Force, I want to thank you for allowing me to present our perspectives on the transition plan for a civil land remote sensing satellite system. I sincerely hope you will consider the recommendations expressed by the states through NCSL and NGA, and if we can be of any assistance in any way, our people would be very pleased to offer every assistance.

Thank you, Mr. Chairman.

Senator STEVENSON. Thank you, Representative Anderson. We will certainly consider seriously those recommendations. We thank you for presenting them so ably.

Mr. Slosky?

Mr. SLOSKY. Mr. Chairman, I'm Leonard Slosky, Assistant to the Governor of Colorado for science and technology. On my right is Mr. Bruce Rado of the Georgia Department of Natural Resources and chairman of the National Governors Association's Earth Resources Data Council.

We're here today representing the National Governors Association. We appreciate the opportunity to again share with the subcommittee the States' concerns on this important issue.

Governor Lamm of Colorado and Governor Busbee of Georgia have long been active in critical natural resource issues facing this country. Both Governors also hold leadership positions in the National Governors Association and both have been involved with the Intergovernmental Science, Engineering and Technology Advisory Panel, ISETAP, which is in OSTP.

ISETAP has permitted State and local governments to indirectly participate in the administration's remote sensing studies. Our

written statement details the States long support for an operational land remote sensing system.

Representative Anderson's statement, as well as witnesses at previous hearings, have detailed the States' increasing interest in Landsat. In April, 1980, as Representative Anderson mentioned, an important meeting of the National Governors' Association, the National Conference of State Legislatures, and ISETAP staff was held to review the NOAA transition plan. This meeting resulted in a set of joint recommentations on behalf of State and local governments to NOAA. This testimony is based on these joint recommendations which are attached to our written statement.

Currently State and local governments comprise a rather modest share of the Landsat data market. We believe, however, that if the operational system and the technology transfer program are responsive to the needs of State and local governments, their market share will increase substantially. We further believe it is unfair to judge the significance of State and local government use of satellite remote sensing solely by the volume of data purchased, since a small amount of data can yield disproportionately large benefits to the Nation by improving the management of our natural resources.

I would like to share with you the perspective of the National Governors' Association on the NOAA transition plan. The States commend NOAA on their efforts in preparing the transition plan in the short time frame required. However, the States are disappointed that the final transition plan is not fully responsive to the priority concerns of the States.

The plan fails to adequately address the critical issues of State participation in program management, technology transfer, and data continuity in the 1980's.

The most important issue to the States is achieving a formal role in national satellite remote sensing policy. Without a formal role, States have little assurance that the system will be responsive to their needs. We believe the States are a special class of users, since they share responsibility for the management of the Nation's natural resources with the Federal Government. In addition, many of the States' needs for remote sensing data result from Federal mandates.

The Governors' firmly held policy is that the States must have an effective voice in the management of the U.S. land remote sensing system, whether it is publicly or privately owned. State and Federal users should have a management advisory mechanism which provides substantial influence upon the system managers' decisions.

The program board, as advocated by NOAA, can serve this function, if properly structured. The position of the National Governors Association is that the Secretary of Commerce should appoint a representative of NGA and NCSL to the program board as nonvoting members. Legislation which may be proposed to transfer operational responsibility from NOAA to a corporation should also include a provision for the appointment of State representatives to the corporation's board of directors.

The second major issue, to the States, is the need for technology transfer, or, in NOAA's terms, market expansion.

A comprehensive and coordinated technology transfer program is required to assist State and local users in developing their capacity to apply Landsat data to their environmental and resource management programs. Without a systematic technology transfer program, the potentially great benefits of the Federal Government's Landsat R. & D. activities will not be fully realized.

The Governors believe that the Federal Government's large investment in R. & D., and in the future the procurement of the operational system, argues for a substantial increase in the resources devoted to technology transfer. The administration's drastic reduction in NASA's fiscal year 1981 technology transfer program will, if realized, severely diminish the States' opportunity to utilize this valuable technology.

The transition plan's discussion of technology transfer is too vague to allow determination as to whether the activities are responsive to the needs of State and local governments. It is unclear to us what activities NASA will continue and what activities NOAA will initiate to assist the users.

NOAA's inclination to use the private sector as its technology transfer agent is also of concern to the Governors. The direction which NOAA seems to be headed in is contrary to the experience of NASA and the States in this field. A Federal technnology transfer program is needed, even if the private sector is fully responsible for data collection and distribution. The provision of initial training to State and local governments on a reimbursable basis is not acceptable.

Any data gaps will have a severe impact on State and local governments. Many State and local governments have recently acquired processing equipment or are in the midst of serious demonstration projects. If data ceases to be available, many existing and potential State and local users will disappear from the market.

As you know, a data gap will probably occur between the explication of Landsat-3 and before the operation of Landsat-D. The Governors urge that maximum efforts be made to reduce or eliminate this data gap.

Therefore, the States support the launch of Landsat-D without the thematic mapper. Landsat-D' should then be flown with the TM. The timely budgeting of the long lead parts for Landsat-D'' and Landsat-D''' is required to prevent another data gap between the interim and fully operational systems.

I would now like to discuss the Governors' recommendations on system performance. Who operates the land remote sensing system is not the important issue for the States. The Governors are concerned with the ability of the system to satisfy State data needs.

The States prefer a sensor configuration of four bands in the visible and reflected infrared regions, comparable to the current MSS banks, but with approximately 30-meter resolution. The system should also include a band in the reflected infrared region sensitive to rock or soil colors, at about 15-meter resolution; and one band in the thermal infrared region.

The preferred configuration would have pointable sensors. This system is essentially the middle system outlined in the transition plan.

State data needs require 6- to 9-day intervals between satellite observation. Statistical analyses have shown that because of cloud cover, a 16- to 18-day repeat cycle does not provide adequate data for a number of renewable resource applications which the States would like to undertake.

As you have heard before, delays and uncertainties in getting data through the Landsat 1, 2, and 3 ground system into the hands of the ultimate users have often precluded the use of the data.

The States recommend that the Landsat-D system and the interim operational system achieve routine delivery of standard products to users within 7 to 14 days of satellite observation. The data processing should be all digital for both real time and retrospective orders.

In addition to these recommendations, the Governors are concerned with three additional policy issues: the role of the private sector, data pricing, and the schedule for implementing the fully operational system.

State and local governments can generally accept the administration's decision to turn the system over to the private sector, through whatever institutional mechanism, if the following conditions are met:

States are provided with representation in the system's management structure; that the Federal Government continues to provide a comprehensive technology transfer program; that the transition to the private sector does not jeopardize data continuity nor does it delay the establishment of the fully operational system; and finally, that data prices are not increased so rapidly or so greatly as to drive State and local users out of the market.

We recognize the legitimate desire to recover a greater portion of the system costs through data sales; however, increasing the price of data too greatly and too rapidly will severely inhibit the development of operational uses by State and local government.

The Governors are also concerned with NOAA's plan to price experimental data from future R. & D. sensors on an equivalent basis as the operational system's data. Such high prices for experimental data will present a major impediment for State and local governments to investigate the advantages of new types of data.

From the perspective of State and local governments, the fully operational system should be implemented as soon as possible. State and local governments currently have needs for such data. NOAA's target of the end of the 1980's for the initiation of the fully operational system seems reasonable.

Since the States require data for the many ongoing environmental and natural resource programs which they administer under State and Federal laws, the States will utilize the best available data at any given time. Thus, if there is delay in upgrading the Landsat-D system or in developing the fully operational system, the States will be forced by their data requirements to turn to other sources of data, possibly including satellite remote sensing systems of other countries.

In closing, we would like to stress that the Governors are most anxious for the U.S. land remote sensing system to move forward toward a truly operational level. The States are prepared to be active, constructive participants in this effort.

We would like to thank the members of the subcommittee for the opportunity to present the views of State Governments on this important issue. We would be pleased to answer any questions which the subcommittee may have.

Senator STEVENSON. Thank you, Mr. Slosky. It's obvious from both your statements that the legislatures and the Governors regard this as a serious, important subject. It's obvious, also, that you've studied it carefully. Your statements are very comprehensive. They anticipate most of our questions.

Rather than ask the remaining questions now, I am going to have to submit them to you in writing. I have to run and vote, and we have five more witnesses. You understand my position?

Mr. ANDERSON. I certainly do, Mr. Chairman.

Senator STEVENSON. I apologize for that.

Mr. ANDERSON. I take one second, Mr. Chairman, to introduce Mr. Paul Tessar, the senior project manager for the National Conference of State Legislatures Natural Resource Information Systems project, whom we could make available, and will, to your staff for any questions the staff may have, or that members of the committee may have, and who's very thoroughly aware of the intimate details of the questions of transition.

Senator STEVENSON. We thank you for that. We'll take advantage of the offer. And now, we will have to recess for about 10 minutes. Thank you.

Mr. ANDERSON. Thank you, Mr. Chairman.

[The statements and material referred to follow:]

STATEMENT OF HON. THOMAS J. ANDERSON, MICHIGAN HOUSE OF REPRESENTATIVES, AND MEMBER, NATIONAL CONFERENCE OF STATE LEGISLATURES NATURAL RESOURCE INFORMATION SYSTEMS TASK FORCE

Mr. Chairman and members of the committee, my name is Tom Anderson. I am a member of the Michigan House of Representatives, and serve as Chairman of the Committee for Conservation, Environment and Recreation. I am here today representing the National Conference of State Legislatures, an organization which serves all of our nation's State Legislatures, and the NCSL Natural Resource Information Systems Task Force, which represents the interests of the states regarding satellite remote sensing and information system technology for use in natural resource policymaking. I also serve as a member of NCSL's State-Federal Assembly, which in 1979 adopted a policy position supporting the Earth Data and Information Service Act (S. 663) for establishing an operational Landsat system. As a member of the Natural Resources and Environment Task Force of the Intergovernmental Science, Engineering, and Technology Advisory Panel, and of the Regional Applications Committee of the Space Applications Board, I have long been active in pursuing state interests regarding Landsat technology.

On behalf of NCSL, I wish to make a statement about the Transition Plan for a civil operational land remote sensing system. I'm not the first person who has represented state legislative interests in the area of satellite remote sensing to this subcommittee. In 1977, Representative Chris Spirou of New Hampshire, House minority leader and member of NCSL's Remote Sensing Task Force, presented testimony regarding Senate Bill 657 to you. It established a domestic, operational earth resources and environmental information system to provide remotely sensed data to a broad community of users. And last year Representative Monroe Flinn, Majority Whip of the Illinois House, presented NCSL's views on the Earth Data and Information Service Act of 1979 (S. 663) and also Senator Harrison Schmitt's bill (S. 875), favoring a privately held operational Landsat system. Their statements reflect ongoing efforts by the states to ensure that their perspectives on Landsat are considered and acted upon.

In November 1979, Presidential Directive NSC-54 designated the National Oceanic and Atmospheric Administration as the lead agency for developing an operational land remote sensing satellite system, and thereby acknowledged the need for a system which could continuously inventory, monitor and evaluate our nation's

resources and environment. NOAA's experience in successfully operating and managing three generations of weather satellites demonstrated that it was prepared to assume the responsibility for land remote sensing in addition to its ongoing atmospheric and oceanic activities. We commend NOAA for its efforts to develop a plan for carrying out the Presidential Directive that is responsive not only to the needs of federal agencies, but also to the requirements of state and local governments.

It concerns me, though, that some of our needs have not yet been adequately considered. In April, the NCSL Natural Resource Information Systems Task Force, of which I am a member, met jointly with the Earth Resources Data Council of the National Governors' Association to discuss the Transition Plan for a U.S. civil land remote sensing system being developed by NOAA. The resulting recommendations pinpoint those issues that we felt needed further attention by the Interagency Policy Group responsible for preparing the Transition Plan. These recommendations were later endorsed by the Intergovernmental Science, Engineering, and Technology Advisory Panel. A copy of the formal joint recommendation is attached to my written statement.

Of major concern to our constituents today, as it has been in the past, is technology transfer or market development, as it is presented in the Department of Commerce's Transition Plan. This concern relates to the development of user capabilities to process and apply satellite data for use in evaluating and monitoring our resources.

States, unlike many federal agencies, have traditionally not had the resources to undertake research and development activities. They are sometimes slow in adopting new ways, especially when it comes to "newfangled techniques." Therefore, it is especially crucial that the state and local levels of government have the opportunity to benefit from this important federally developed technology.

An effective Landsat system recognizes the significant role of the states in resource management, and nurtures their interests in developing a solid data base as a matter of public policy. A comprehensive technology transfer program would help states develop their capacity to analyze and apply Landsat data in reconciling their particular resource management problems. An effective program should include orientation, hands-on training, demonstrations, involvement of policymakers who will use Landsat technology in their decision-making, and systems development assistance for state and local capabilities. Landsat data have been used independently and in concert with other data sources to assist in many state and local planning and management functions.

The Regional Remote Sensing Applications Program (RAP) initiated by NASA in 1977 recognized the crying need for state and local government entities to learn to apply Landsat technology. The three NASA field installations which implement the program, each covering a specific geographical area of the United States, use a variety of techniques to acquaint prospective and current users with developments in the remote sensing field, as well as with RAP activities. Cooperative demonstrations of how Landsat technology may be applied to specific user needs are a key part of the program.

Cooperative projects of this kind give users the chance to decide, on the basis of first-hand experience, the extent to which remote sensing data can contribute to their specific informational needs. If the user decides to build an independent capability to use Landsat data, NASA provides follow-on assistance for incorporating the technology into the user agency's data system. Part of this technical assistance includes introducing the user to various hardware systems and services that are available from the private sector. This one-on-one interaction is remarkably effective in acquanting state, and to a lesser extent, local users in the "how" and "why" of Landsat data as we know it today.

For example, in the region serving the 14 western states, NASA has helped develop 13 operational digital processing and analysis capabilities in 8 states. The Eastern Regional Remote Sensing Applications Center has activities in several of its 19 states; three of them have expanded their Landsat capabilities, apparently as a result of the positive interactions with the Eastern RAP program. Several other states in that region are having successful encounters with Landsat technology through the program—a prerequisite to developing a market in any state. And in the region serving the 17 south central and southeastern states, 10 have an operational system housed either in a university setting or a state agency. An additional 5 states in that region are seeking funds and/or institutional arrangements to implement Landsat processing capabilities.

As an aside, I would like to commend the efforts of this Subcommittee to defend the FY 81 budget of the Regional Applications Program. At the height of this spring's budget cutting fever, the Administration had proposed cutting the NASA Technology Transfer budget from $12.5 to $7.5 million; and the RAP budget, which

is included in Technology Transfer, from $4.1 to $1.8 million. These cuts would have had a serious impact on NASA's ability to work with state and local governments on Landsat demonstration projects. NCSL is most pleased that this Subcommittee raised the authorization level for Technology Transfer to $10 million, and that its counterpart in the House raised that authorization level to $12 million..

Surely the success of these programs reinforces the need for ongoing technology transfer. Without the involvement of programs like RAP, it is highly unlikely that the states would have developed in-house capabilities to the extent they have. Nor is it likely that the appropriate institutional climate would have evolved as rapidly as it has in many of the states without the presence of a catalyst such as RAP.

Unfortunately, many states have not yet had an opportunity to participate in these programs, and it would therefore be extremely shortsighted to abandon them. Yet I feel that the federal government is dragging its feet. Many technology transfer functions are being delegated to the private sector, and although I strongly support the involvement of that sector in providing value added services, I am not altogether convinced that it is to the states' benefit to rely upon private consultants for developing their Landsat and natural resource information systems cabilities. All routine state Landsat users have, to date, developed in-house processing capabilities in either a state agency or a state university. This same approach seems especially desirable for the 80's, as more sophisticated sensors with increased resolution become a reality.

The role of private industry, then, might best be viewed as only one component of a multi-faceted approach to transferring technology to the user communities. The federal government must surely assume much of the responsibility for this task, because it is the federal government that truly has the interests of the states at heart: they have no need to develop a clientele of dependent users, which is what the private sector *must* do in order to profit. Further, the private sector cannot respond to the changing user requirements that exist at the state and local levels, as well as a state or local agency that has a mandate to do so.

The issue of how the transfer of technology is accomplished in the future is a top priority from our standpoint, because without the transfer, Landsat is nothing but an "exotic toy." I say "exotic toy" with some hesitation, because I don't wish to see Landsat lose support in the Congress and administration. If Landsat developed a reputation as a toy, this valuable program could suffer considerable setbacks which could require several years to recover from. The fact is, if we don't have the capability to use Landsat, its value is significantly reduced. And without Federal assistance, the process for developing state capabilities will be greatly delayed.

There are several other matters that need to be resolved to the mutual satisfaction of the many user groups concerned. Because of the limited time, I will review them quickly. They are elaborated upon in the technical appendix.

One of the most important of our remaining concerns is representation on the program Board. It is my understanding that the Transition Plan does not provide for the involvement of NCSL and the National Governors' Association in the Program Board as required in the Presidential Directive. Because the states are partners with the Federal government, and share major responsibilities for resource management, I feel that we should be represented on the program Board, at least in an ex officio capacity. Membership on a general user advisory committee would not fulfill the intent of the President's decision, nor would it adequately serve the interests of the states.

Another problem area pertains to NOAA's goal of developing a self-supporting system. The states feel that the price of the data should be limited to the cost of its reproduction, handling and distribution. Otherwise, it is likely that some state and local government entities may be priced out of the market. It should be a matter of public policy for the federal government to encourage the use of substantive, timely data in natural resources policymaking. A corollary to this recommendation is the need for states to be able to reproduce land remote sensing data for their internal use. Any changes in the copyright laws or the Freedom of Information Act could not be supported if they would complicate or restrict access to and use of the data.

The need for data continuity is critical, because a data gap would severely hinder the activities of operational facilities. The impact would probably be most disastrous if a gap occurred during the growing season. Every effort must be made to prevent this.

The states have also expressed their needs with respect to frequency of satellite observation, recommending that there always be two observing satellites in orbit to provide routine 8-day coverage. Minimum performance standards for the ground system have also been specified. Those standards would ensure that routine products be delivered to users within 7-14 days of satellite observation, and that selected

data be delivered in 24-48 hours for emergency situations such as flooding or other catastrophic events.

A preferred configuration for the Fully Operational System has been described by the states. They favor a sensor configuration with at least 4 bands in the visible and reflected infrared regions, and with increased resolution over current multispectral scanner capabilities. One band in the thermal infrared region should also be included, as well as a band sensitive to rock or soil "colors".

With respect to standard products, the states agree that the current range of standard digital and film products is adequate, but would like to see additional consideration given to the range of map projections available in the future.

Finally, the states are concerned that historical Landsat data may be destroyed. They therefore have recommended that all land remote sensing data should be kept in archives forever; or, at a minimum, the highest quality data for each scene from each season should be kept.

Each of these concerns is fully detailed in the attached copy of the Joint Recommendations of NCSL's Task Force and NGA's Earth Resources Data Council. On behalf of the National Conference of State Legislatures and the Natural Resource Information Systems Task Force, thank you for allowing me to present our prespectives on the Transition Plan for a civil land remote sensing satellite system. I do hope that you will consider the recommendations expressed by the states through NCSL and the national Governors' Association. If we can help you further, please feel free to call on us.

[The following information was subsequently received for the record:]

QUESTIONS OF THE COMMITTEE AND THE ANSWERS THERETO

DATA REQUIREMENTS

Question. Your organizations, and others such as the intergovernmental science, engineering and technology advisory panel, have been very active in bringing to the attention of the Federal Government the satellite remote sensing needs of State and local governments.

Has there been any attempt to define the data requirements for State and local governments—in terms of the amount of data that will be needed?

Can these requirements be defined at this time?

Answer. In the past, Mr. Chairman, our efforts have focused on documenting the applications of Landsat data by State and local governments. We feel that the significance of state Landsat uses, in terms of public policy development and promotion of the common good, is far above the actual volume of data usage.

To answer your question more directly, we have worked closely with the Department of Commerce in their survey of user requirements, including State and local governments. We feel their estimates of the amount of data required by States are reflective of future demands. They have projected a State usage level of 2,000 to 4,000 scenes per year, and we feel comfortable with the lower end of that estimate. This allows an average usage of 40 scenes per State per year.

DATA COST

Question. Why do you think that some States and local governments might be priced out of the market because of the objective to develop a self-supporting remote sensing system? In the cases that we have heard of, the cost of analyzing the data far exceeds the cost of the data, and I do not understand why the Federal Government—the taxpayer—should continue to provide remote sensing data for the cost of reproduction. Would you comment please.

Answer. The purpose of government is to do that for people which they can't do for themselves. The provision of land remote sensing data clearly fits within this category, with the Federal Government procuring, launching and operating satellites and providing and operating data distribution facilities.

Many State applications of Landsat are the result of programs in which the Federal Government has mandated State participation. In most cases, these programs are not adequately funded, and in almost all cases, the data component of these programs is seriously underfunded. It seems hypocritical of the Federal Government to require States to participate and underfund data activities on the one hand, and to charge premium prices for one of the best data sources, on the other hand.

Over and above these Federal mandates, however, the States have many actual and potential Landsat applications. We very strongly feel that it is in the public

interest to encourage and subsidize the use of substantive data for natural resources policy formulation, planning, management and monitoring. It should be a matter of public policy to make Landsat data as accessible and as affordable as possible.

Mr. Chairman, we get very nervous when we hear figures such as a ten- or twenty-fold increase in data costs. In these times of inflation, unemployment, and tax cutting, increasing demands are made of our State treasuries. In my own State of Michigan, for example, we are facing a potential budget deficit of $500 million in an $8 billion budget, which will result in substantial cuts in many areas of services. Natural resources information, as valuable as it may be, would not be realistically funded if prices were increased several-fold. Natural resources planning and management, much less information, simply cannot compete for funds when there are crying needs for increased services in mental health, education, and social welfare.

Michigan is just now embarking on a natural resource inventory authorized by a recent statute. Implementation of this act can be assisted by satellite information, but only if it is affordable and cost-effective in relation to alternative approaches. A large price increase would surely mean that Michigan could not afford this valuable information so vital to managing our resources. Michigan's example is valid for many areas of the country.

PROGRAM BOARD

Question. A major concern of yours is that the transition plan does not provide for the involvement of the National Conference of State Legislatures and the National Governors Association in the Program Board. The statement issued by the White House on November 20, 1979, states that the National Governors Association and National Conference of State Legislatures will be invited to participate in the Program Board. But the participation of these two organizations in the Program Board is not mentioned in the transition plan. Do you know why?

Have you talked to NOAA about this? How about the Secretary of Commerce; he's a reasonable man, if the President says that you will participate, I would think that he would follow the instructions of the President.

Answer. Mr. Chairman, this question is crucial and quite difficult. As to why the Department of Commerce has not included NCSL and NGA on the Program Board, I can only offer a few observations and opinions.

NOAA has told us that the Program Board must be an Interagency Policy Board because it will be dealing with privileged budgeting information. We feel that there are sufficient provisions for secrecy under the Federal Advisory Committee Act. It appears that the NOAA legal staff has spent a great deal of time documenting why we cannot participate in the board. I wish they had invested this effort in figuring out how we could participate.

We have not spoken directly to the Secretary of Commerce on this matter, but an Assistant Secretary of NOAA, Dr. George Benton, who chaired the Interim Policy Group (IPG), is well aware of our concern. Mr. Slosky has discussed this matter at IPG meetings and mentioned it several times in written comments on the various drafts of the Transition Plan.

This matter has also been pursued with Dr. Frank Press, the President's Science Advisor, and the Intergovernmental Science, Engineering and Technology Advisory Panel, to no avail.

We seem to be beating our heads against the wall on this matter and appeal to you to remedy this situation.

TECHNOLOGY TRANSFER TO USERS

Question. Clearly, one of the major concerns of the state and local governments is related to the development of user capabilities to process and apply satellite data. As I understand it, a comprehensive technology transfer program should include orientations and demonstrations, training of individuals and system development assistance. I presume you have talked to NOAA about this during their development of the transition plan. What response have you received from NOAA?

What could be done by the Congress to insure a comprehensive technology transfer program is undertaken by NOAA and continued by whoever manages the fully operational system?

Answer. NOAA's verbal response on Techonolgy Transfer has been very encouraging. They have said that NASA will continue to operate the Regional Application Program for the next five years or so, and that they will offer additional market development programs in the near future.

Statements in the Transition Plan and other places, however, have not been as encouraging. The Transition Plan, for example, states that:

"NASA *probably* will continue to share with users technology and techniques for acquiring, processing and interpreting land remote sensing satellite data as part of its basic responsibility for R & D in space-related technology. NASA also *could* continue testing new techniques and potential new applications in joint projects with users in *all* sectors." (emphasis added).

The Transition Plan also incorrectly sets the NASA technology transfer budget at $5.7 million for fiscal year 1981. The fiscal year 1980 budget is $10.1 million and the fiscal year 1981 budget authorization level set by this committee is $10 million, and $12 million was authorized by the House Committee for NASA Technology Transfer. As I understand it, the Transition Plan also does not adequately address the budgeting requirements for NASA Technology Transfer in succeeding years.

These types of inconsistencies are very serious from our standpoint and lead us to question the administration's commitment to technology transfer assistance to state and local governments. The fact is, if we don't have the capability to use landsat, its value is significantly reduced, and without Federal assistance, the process for developing state capabilities will be greatly delayed.

What we would ask from the Congress on this issue is a firm, consistent and supportive insistence on the provision of technology transfer assistance to state and local governments. It is not important whether this help is provided by NASA, NOAA or another federal agency, but it must be provided directly by the federal government.

STATEMENT OF LEONARD C. SLOSKY AND BRUCE Q. RADO, REPRESENTING THE NATIONAL GOVERNOR'S ASSOCIATION

Mr. Chairman and members of the subcommittee, I am Leonard Slosky, Assistant to the Governor of Colorado for Science & Technology. Accompanying me is Mr. Bruce Rado, Supervisor of the Natural Resources Unit of the Georgia Department of Natural Resources and Chairman of the Earth Resources Data Council of the National Governors' Association/Council of State Planning Agencies. We are here today representing the National Governors' Association (NGA). We appreciate the opportunity to again share with the Subcommittee the states' perspective on the United States civil operational satellite land remote sensing system.

Governor Lamm of Colorado and Governor Busbee of Georgia have long been active in critical natural resource issues facing this country. Governor Lamm is Chairman of the National Governors' Association's Committee on Natural Resources & Environmental Management. He is also Chairman of the Natural Resources and Environment Task Force of the Intergovernmental Science, Engineering & Technology Advisory Panel (ISETAP). ISETAP was established by the National Science and Technology Policy Act of 1976 to advise the Director of the Office of Science and Technology Policy (OSTP), Executive Office of the President, on scientific and technical issues of concern to state and local governments. ISETAP is composed of state, regional and local government officials.

Governor Busbee is a former member of the NGA Committee on Natural Resources and Environmental Management and the former vice-chairman of ISETAP. He is currently chairman of the NGA Committee on International Trade and Foreign Relations. Governor Busbee will take over as chairman of the National Governors' Association in August, 1980.

HISTORY OF STATE INVOLVEMENT

States have long supported the concept of an operational land remote sensing system. In 1977 the Governors' Association adopted a policy position supporting a Landsat follow-on program. In June 1978, the Intergovernmental Science, Engineering and Technology Advisory Panel (ISETAP), completed a major study of Landsat from the perspective of state and local governments under the direction of Governors Lamm and Busbee and State Representative Tom Anderson from Michigan. This report surveyed the extent of state use and recommended that an operational commitment was needed for increased state use of the data.

Through ISETAP, the Office of Science & Technology Policy has permitted state and local governments to indirectly participate in the Administration's Integrated Remote Sensing Systems Study, the Private Sector Involvement Study and the Interim Policy Group which assisted the National Oceanic & Atmospheric Administration (NOAA) in the preparation of the Final Transition Plan for Civil Operational Land Remote Sensing System from Space. The states deeply appreciate Dr. Frank Press's support in involving ISETAP in these studies.

In August 1978, the National Governors' Association adopted a policy position at their annual meeting supporting the ISETAP report, and urging the Federal government to establish an operational Landsat Information System.

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In September 1978, the Council of State Planning Agencies, in consultation with the National Governors' Association, appointed the Earth Resources Data Council to serve as the nucleus of a state-federal communication and advisory network on remote sensing and natural resources data issues. Surveys and recommendations prepared by the Data Council during the past year and a half have continued to affirm state support of a federal commitment to an operational civilian land remote sensing system. The Earth Resources Data Council is composed of state planning and program officials from each of the ten standard federal regions. Members maintain contact with appropriate state officials in their regions, and use this informal network to obtain the necessary feedback and perspective on important natural resource data issues.

A major impediment to increased state use has been the risk of investing in the capability to use Landsat data which, given its experimental nature, may cease to be available at any time. The Presidential Directive in November 1979, designating the National Oceanic and Atmospheric Administration to manage the operational civilian remote sensing system, was welcomed by the states as a major step towards accomplishing a truly responsive operational system. It was also an important directive in that it recognized the states' role, and attempts to incorporate state concerns from the beginning of the process.

In April 1980, a joint meeting of the National Governors' Association/Council of State Planning Agencies' Earth Resources Data Council, and the National Conference of State Legislatures' Natural Resource Information Systems Task Force, with participation of the Intergovernmental Science, Engineering & Technology Advisory Panel's Natural Resources and Environment Task Force staff was held to review the NOAA Transition Plan. This important meeting resulted in a set of joint recommendations on behalf of state and local governments to NOAA. This testimony is based on these joint recommendations, which are attached.

STATES AS USERS OF LAND REMOTE SENSING DATA

State officials know that responsible management of this nation's environment and natural resources is as important to the future of the state and its development as it is to the nation as a whole. In addition, both state and federal legislation and regulations have recognized the important management role of states and have increased the authority and responsibility of state governments in this area. It must be recognized that states are partners with the federal government in natural resources and environmental management.

State interest in the future of land remote sensing is an indication of a growing concern that more cost-effective technologies must be available to meet the management and budget demands of the 1980's. The ISETAP survey in 1978 found that seven states have independent, ongoing computer-assisted Landsat analysis and application capabilities, and that nine others are likely to have operational Landsat capabilities underway within several years. At least 35 states have used Landsat in 157 applications covering a variety of resource management programs. A survey sponsored by the Earth Resources Data Council in 1979 also indicates that development of operational capabilities to use satellite remote sensing data by states can be tied directly to the presence of an information system for resource management. Sixteen states now have operational natural resource information systems while ten others have systems under development.

Currently state and local governments comprise a rather modest share of the Landsat data market. We believe, however, that if the operational system and the technology transfer program are responsive to the needs of state and local governments, their market share will increase substantially. We further believe that it is unfair to judge the significance of state and local government use of space remote sensing solely by the volume of data purchased. A small amount of data can yield disproportionally large benefits to the nation by improving state management of natural resources.

STATE PERSPECTIVE ON THE TRANSITION PLAN

The states are disappointed that the Final Transition Plan for Civil Operational Land Remote Sensing from Space is not responsive to priority concerns of the states. The Transition Plan fails to adequately address the critical issues of:

State participation in program management; technology transfer; and data continuity in the 1980's.

State participation in program management

For a number of years, the states have argued for a formal role in national satellite remote sensing policy. For a remote sensing system to be responsive to

state needs, the states should be involved in the management of the system. The states are a special class of users; they share responsibility for the management of the nation's natural resources with the federal government. Many of the states' needs for remote sensing data result from federal mandates.

The governors' firmly held position is that the states must have an effective voice in the management of the U.S. operational land remote sensing system whether it is publicly or privately operated. By management we do not intend a cumbersome operating structure. For any system to be effective, a single organizational unit must be ultimately responsible. However, the operational system will be an important data source for state and local governments, as well as a number of federal agencies. Therefore, federal and state users should have a management advisory mechanism which provides substantial influence upon the system manager's decisions. The Program Board as advocated by NOAA can serve this function.

The position of the National Governors' Association is that the Secretary of Commerce appoint a representative of the NGA and the NCSL to the Program Board as non-voting members. The governors do not believe that NOAA has been responsive to Presidential Directive/NSC-54 which stated that NGA and NCSL would be invited to participate on the Program Board.

The states support NOAA's concept of a User Advisory Committee with broad representation from all sectors of the user community including state and local government. Membership on the Advisory Committee, however, is in no way a substitute for state representation on the Program Board.

Legislation which may be proposed to transfer operational responsibility from NOAA to a corporation should include a provision for the appointment of state representatives to the corporation's board of directors.

Technology transfer (market Expansion)

A comprehensive and coordinated technology transfer program is required to assist state users in developing their capacity to analyze and apply Landsat data to state resource management problems. A systematic and ongoing technology transfer program is essential as an integral part of an operational land remote sensing satellite program. It is important to recognize state and local governments as partners with the federal government in providing services to citizens and the private sector.

Without a systematic technology transfer program, the potentially great benefits of the federal government's Landsat research and development (R&D) activities will not be fully realized. The governors believe that the federal government's very large investment in R&D and in procurement of the operational system argues for a substantial increase in the resources devoted to technology transfer.

ISETAP and NGA Studies of state Landsat use reveal the important role of the National Aeronautics and Space Administration (NASA) technology transfer activities in instigating state use of Landsat data. Most states date their serious investigation of this technology to the initiation of the Regional Remote Sensing Applications program by NASA in 1976. The Administration's drastic reduction in NASA's fiscal year 1981 technology transfer program will severely diminish the states' opportunity to utilize this valuable technology.

The Transition Plan's discussion of this vital area is too vague to allow a determination as to whether the activities are responsive to the needs of state and local governments. It is unclear what activities NASA will continue and what activities NOAA will initiate to assist users. It is most important that the expertise which NASA has painfully acquired over the last eight years not be lost. The states are concerned that the continuity of technology transfer efforts be maintained during the transition of management responsibilites for the land remote sensing satellite system.

NOAA's inclination to use the private sector as its technology transfer agent is of serious concern to the states. The direction NOAA seems to be headed is contrary to the experience of NASA and the states. The states' experience in applications demonstrations indicates that, by themselves, value added firms are not effective technology transfer agents for this technology. It is not in the interest of such firms to transfer technology since this undercuts their market.

The governors feel very strongly that for a technology transfer program to be effective. it must be conducted under the direction of a federal agency. The federal agency, of course, may find it advantageous to utilize a private contractor. A federal technology transfer program is needed even if the private sector is fully responsible for the data collection and distribution system. The provision of initial training to state and local governments on a reimbursable basis is not acceptable.

An effective technology transfer program will require a number of specific features. These features are outlined in the attachment to this testimony.

Data continuity in the 1980's

Any data gaps will have a severe impact on state and local governments. Many state and local governments have recently acquired processing equipment and personnel or are in the midst of serious demonstration/evaluation projects. If data ceases to be available many existing and potential state and local users will disappear from the market.

A data gap will probably occur between the expiration of Landsat-3 and the operation of Landsat-D. The governors urge that maximum efforts be made to reduce or eliminate the data gap between Landsat-3 and Landsat-D. Therefore, the states support the launch of Landsat-D without the Thematic Mapper (TM). Landsat-D' should be flown with the TM. The timely budgeting of the long lead parts for Landsat-D'' and Landsat-D'' is required to prevent a data gap between the Interim Operational System and the Fully Operational System.

For the governors to support the Transition Plan the concerns with the Program Board, technology transfer, and data continuity must be more adequately addressed.

RECOMMENDATIONS ON SYSTEM PERFORMANCE

Who operates the land remote sensing system is not the important issue with the states. The governors are most concerned with the ability of the system to satisfy state data needs. Following is a summary of the state's performance specifications. These are independent of the institutional arrangements which are eventually developed for operating the system. These specifications should definitely be met by the Fully Operational System, and should be met to the extent practical by the Interim Operational System.

The fully Operational system sensor configuration

States prefer a sensor configuration of 4 bands in the visible and reflected infrared regions of the electromagnetic spectrum, comparable to current MSS bands, but with approximately 30 meter resolution. The preferred system would also include a band in the reflected infrared region sensitive to rock or soil "colors," at about 15 meter resolution, and one band in the thermal infrared region.

The preferred configuration would have pointable sensors. Such a sensor would allow for data collection (by tasking) on a shorter repeat cycle. The ability to capture data over a path obscured by cloud cover the previous day, or perhaps anticipated to be covered by clouds the next day, would be advantageous. This system is essentialy the middle system outlined in the Transition Plan.

Frequency of satellite observation

State data needs require 6- to 9-day intervals between satellite observation. Statistical analyses have shown that because of cloud cover probabilities, a 16- to 18-day repeat cycle does not provide adequate data for a number of demonstrated renewable resource applications which the states would like to undertake.

The configuration of one prime operating satellite in orbit with a second back-up satellite stored in orbit and tasked for special purposes will not provide the states with an adequate source of data.

The states recommend that in the Fully Operational System there always be two observing satellites in orbit to provide 8-day U.S. Coverage. Between now and the Fully Operational System, two-satellite coverage should be provided to the maximum extent feasible. It is also important that all systems both in space and on the ground have appropriate back-up or redundancy provisions.

Data processing system

In the Landsat 1-3 systems, delays and uncertainties in getting data through the ground system into the hands of the ultimate users have often precluded use of the data for may applications. The states recommend that the Landsat-D system and the Interim Operational System achieve the following minimum performance standards:

Routine delivery of standard products to users within 7-14 days of satellite observation.

Delivery of selected data in emergency situations within 24-48 hours.

Delivery of data ordered on a retrospective basis within 14 days.

The data processing system should be all digital for both real time and retrospective orders.

The Fully Operational Systems probably should be designed to meet shorter data handling schedules than are specified above.

Data products

The standard data products currently offered through the EROS Data Center (EDC) should be continued and extended to TM data. In addition, TM subscenes (perhaps by image quadrants) should also be available in a digital format.

Archiving

Historic data are necessary if the states are to be able to make effective policy and program decisions on natural resource management. Because these data are not replaceable, all domestic land remote sensing satellite data should be archived forever if it is relatively cloud free and error free. At a minimum, it is absolutely essential that the states have access to the highest quality (i.e., the most cloud free, error free) scene from each season.

ADDITIONAL POLICY ISSUES

In addition to these recommendations, the governors are concerned with three important remaining issues, the role of the private sector, data pricing and the schedule for implementing the Fully Operational System.

Private sector role

An issue currently receiving considerable attention within the Administration and within the Congress is the proper role for the private sector in the U.S. Civil Operational Land Sensing Satellite System.

Philosophically, state and local governments believe that the United States' civil operational land remote sensing system should be considered in the same context as census, cartographic, geological, and meteorological data which are provided as a public service of the federal government.

State and local governments can generally accept the Administration's decision to turn the system over to the private sector (through whatever institutional mechanism) if the following conditions are met:

States are provided with representation in the system's management structure;

The federal government continues to provide a comprehensive technology transfer program to assist state and local governments in utilizing this technology;

The transition to the private sector does not jeopardize data continuity nor does it delay the establishment of the Fully Operational System;

Data prices are not increased so greatly or so rapidly as to drive state and local users out of the market.

The states' primary concern is that their data needs are met and not with the institutional arrangement for involving the private sector.

The Federal government should avoid an institutional arrangement with the private sector which would increase the government's cost or risk above that which would occur through the direct government operation of the system.

There exists an appreciable amount of private sector activity in providing equipment, software and occasional analysis of Landsat data and products to support state capabilities. Due to the developmental nature of Landsat and related technology, the involvement of these private forms is important, since many smaller data users do not want to make large capital outlays for equipment in the face of a rapidly changing technology.

At the same time, it should be emphasized that since the vast majority of states are planning to develop their own internal Landsat data analysis capabilities, they will not rely heavily on the private sector for these services. However, states will continue to rely on the private sector as the major supplier of equipment. Most states can develop the necessary data processing expertise, core equipment and application discipline knowledge to be able to effectively develop an in-house capability to use satellite remote sensing data. From a cost point of view, the repetitive and multi-purpose nature of Landsat use makes it significantly more economical for state government to develop an in-house capability rather than to contract for services.

Data pricing

The issue of data pricing is one that deeply concerns the states. The states fear that the pricing decisions may limit or exlcude many state and local users of satellite data.

We recognize the legitimate desire to recover a greater portion of system costs through data sales. However, increasing the price of data too rapidly will severely inhibit the development of operational uses by state and local governments. Once a state has evaluated the utility of Landsat data and has decided to make an operational commitment to its use, a price increase of several fold will not have major impact as long as Landsat data remaines cost-effective.

On the other hand, high data prices will discourage potential state and local goverment users from exploring the utility of Landsat data. This problem should be addressed through the technology transfer program.

The governors are also concerned with NOAA's plan to price experimental data from future R&D sensors on an equivalent basis as the operational system's data. Such high prices for experimental data will persent a major impediment for state and local governments to investigate the advantages of new types of data.

Schedule for implementing the fully operational system

From the perspective of state and local governments, the Fully Operational System with the specifications listed above, should be implemented as soon as possible. State and local governments currently have needs for such data. If these improved data were available today there would be significantly greater use by the states.

Since the states require data for the many ongoing environmental and natural resource programs, which they administer under state and federal laws, the states will utilize the best available data at any given time. Thus, if there is delay in upgrading the Landsat-D system or in developing the Fully Operational System, the states will be forced by their data requirements to turn to other soures of data, possibly including satellite remote sensing systems of other countries.

In closing, we would like to stress that the governors are most anxious for the U.S. land remote sensing system to move forwards towards a truly operational level.

The states are prepared to be active, constructive participants in this effort.

We would like to thank the members of the Subcommittee for the opportunity to present the views of state governments on this important issue.

We would be pleased to answer any questions which the Subcommittee may have.

[The following information was subsequently received for the record:]

QUESTIONS OF THE COMMITTEE AND THE ANSWERS THERETO

DATA REQUIREMENTS

Question. Your organizations, and others such as the Intergovernmental Science, Engineering and Technology Advisory Panel, have been very active in bringing to the attention of the federal government the satellite remote sensing needs of state and local governments.

Has there been any attempt to define the data requirements for state and local governments—in terms of the amounts of data that will be needed? Can these requirements be defined at this time?

Answer. It is extremely difficult to estimate the volume of data which state and local governments will require since their demand is highly sensitive to the quality and timeliness of data available as well as the adequacy of the technology transfer program—all of which are uncertain.

If one assumes that the system is responsive to state and local data needs and that an adequate technology transfer program is initiated immediately, I would estimate that 2,000 scenes per year of digital data and imagery would be used by state and local governments in the foreseeable future.

DATA COST

Question. Why do you think that some states and local governments might be priced out of the market because of the objective to develop a self-supporting remote sensing system? In the cases that we have heard of, the cost of analyzing the data far exceeds the cost of the data, and I do not understand why the federal government—the taxpayer—should continue to provide remote sensing data for the cost of reproduction. Would you comment please.

Answer. Presently, the amount of Landsat data used is equivalent to about $6 million per year. Total system costs are estimated to be $100 million to $200 million per year. Assuming a doubling of the volume of data sold, the price of the data would have to be increased 8 to 16 times to recover the full cost of the system. If this occurred the cost of the data would equal or exceed the cost of analysis.

State and local governments believe that it is proper for the federal government to provide financial support to the U.S. Operational Remote Sensing System for several reasons. First, we consider Landsat type data to be in the same general class as census and meteorological data which should be provided by the federal government at minimal cost. Second, it it in the national interest to foster the use of satellite remote sensing data, since better data will result in better decisions. Third,

many of the applications for which states would like to use Landsat data are mandated by federal laws and regulations.

PROGRAM BOARD

Question. A major concern of yours is that the transition plan does not provide for the involvement of the National Conference of State Legislatures and the National Governors Association in the program board. The statement issued by the White House on November 20, 1979, states that the National Governors Association and the National Conference of State Legislatures will be invited to participate in the Program Board. But the participation of these two organizations in the Program Board is not mentioned in the transition plan. Do you know why?

Have you talked to NOAA about this? How about the Secretary of Commerce; he's a reasonable man, if the President says that you will participate, I would think that he would follow the instructions of the President.

Answer. You are correct, although Presidential Decision-NSC-54 indicated that NGA & NCSL would participate on the Program Board, the Transition Plan contains no such provision.

It has been extremely frustrating to us that even with a specific directive from the President, NOAA has been unable to develop a satisfactory mechanism for state participation on the Program Board. We have had extensive discussions of this matter with top officials of NOAA. NOAA's position is that the routine attendance of any non-federal (state) employee at Program Board meetings cannot be permitted since this would subject the Program Board to the open disclusure provisions of the Federal Advisory Committee Act, which is not acceptable to NOAA. As of this time, there have been no direct conversations with the Secretary of Commerce.

TECHNOLOGY TRANSFER TO USERS

Question. Clearly, one of the major concerns of the state and local governments is related to the development of user capabilities to process and apply satellite data. As I understand it, a comprehensive technology transfer program should include orientations and demonstrations, training of individuals and system development assistance. I presume you have talked to NOAA about this during their development of the transition plan. What response have you received from NOAA?

What could be done by the Congress to insure a comprehensive technology transfer program is undertaken by NOAA and continued by whoever manages the fully operational system?

Answer. From our discussions with NOAA, we have the impression that technology transfer is considered a second priority to the development of the data acquisition system. From the state and local government perspective, technology transfer is an integral part of the operational remote sensing system since the data is useless if you don't know how to apply it.

State and local governments would strongly urge Congress to require NOAA to conduct a comprehensive and continuing technology transfer program. The principal obstacle to achieving this is expected to be obtaining adequate appropriations. Even if the entire operational system is owned and operated by the private sector, a Federal technology transfer program will probably be necessary.

I trust that this is responsive to the Subcommittee's questions. Please feel free to call on me for any clarification or further questions.

Technical Appendix

RECOMMENDATIONS OF THE NATIONAL GOVERNORS' ASSOCIATION, NATIONAL CONFERENCE OF STATES LEGISLATURES, INTERGOVERNMENTAL SCIENCE, ENGINEERING AND TECHNOLOGY ADVISORY PANEL, NATURAL RESOURCES AND ENVIRONMENTAL TASK FORCE FOR THE FINAL TRANSITION PLAN FOR THE NATIONAL CIVIL OPERATING REMOTE SENSING PROGRAM

1. Data continuity

The issue of data continuity is crucial for all users. The States recommend that Landsat-D be launched without the Thematic Mapper (TM) so that data for the growing season of 1982 are available. This will require a launch in early February 1982 and a 60-day checkout/shakedown period so that data are acquired regularly after early April 1982.

The States recommend that the TM and the Multispectral Scanner (MSS) be on Landsat-D'. A launch in early December 1983, with a 60-day checkout period for MSS data and a 6-month checkout period for TM data, are recommended so that 8-

day MSS coverage and 16-day TM coverage are available for the 1984 growing season.

Landsat-3 cannot be counted upon past the 1981 growing season. Therefore, an accelerated NASA option II (as described above) is recommended to maintain continuous MSS coverage and provide the earliest possible TM coverage.

2. Frequency of satellite observation

State data needs require 6- to 9-day repeat cycles. Statistical analyses have shown that because of cloud cover probabilities, a 16-18-day repeat cycle does not provide adequate data for a number of renewable resource applications in which the States are interested.

The configuration of one prime operating satellite in orbit with a second back-up satellite stored in orbit and tasked for special purposes will not provide the States with an adequate source of data.

The States recommend that in the Fully Operational System there always be two observing satellites in orbit to provide 8-day U.S. coverage. Between now and the Fully Operational System, two-satellite coverage should be provided to the maximum extent feasible. It is also important that all systems both in space and on the ground have appropriate back-up or redundancy provisions.

3. Technology transfer

A comprehensive and coordinated technology transfer program is required to assist State users in developing their capacity to analyze and apply Landsat data to State resource management problems.

A systematic and ongoing technology transfer program is essential as an integral part of an operational land remote sensing satellite program. It is important to recognize State and local governments as partners with the Federal Government in providing services to citizens and the private sector. State and local governments have major responsibilities for resource management, many of which are mandated by Federal law.

From a public policy standpoint, it is crucial that *all* levels of government are afforded the opportunity to benefit from federally developed technologies.

Without a systematic technology transfer process, the potentially great benefits of the Federal Government's Landsat research and development (R & D) activities will not be realized by State and local governments. States traditionally have not funded or undertaken R & D activities. State and local governments do not usually have R & D funds which can be used to examine whether a new technology like Landsat can meet their needs. Therefore, the Federal resources devoted to Landsat technology transfer should be significantly increased to meet the demands of all interested State and local governments. A technology transfer program fragmented among a number of Federal agencies cannot meet the needs of State and local governments.

An effective technology transfer program will require a number of specific features. The most important of these are outlined below:

Orientation.—Awareness of technology and applications must be raised at both the policy and technical levels. In addition, general awareness by citizens of capabilities and applications of land remote sensing should be fostered.

Training.—One-day to one-month applied courses for technical staff are needed. The training must be hands-on, and oriented to real problems.

Demonstration.—Low cost, low risk projects to demonstrate practical applications of the technology are required. These demonstrations should be in the user's environment, in a project area and application area of his choosing, and tailored to meet his requirements. Such an approach will familiarize users with applications in his operational setting, overcome many reservations and instill the confidence required to develop user analysis capabilities.

Involvement of policymakers.—Governors, legislators, and State program managers must approve budgets for the utilization of Landsat data. A clear understanding of the technology and its applications will assist State policymakers in discharging these responsibilities.

Systems development assistance.—In the building of State and local capabilities, the following types of assistance are required:

Hardware procurement consultation, including specifications, advice on proposal evaluation, etc.

Software assistance, such as improved access to existing software, development of new/generalized software, assistance, in procuring commercial software, and help in implementing software on user's hardware.

Analysis procedure development, in data classification and display, data verification/validation, multi-source data analysis and composite mapping.

Continuing technical assistance.—Ongoing consultation services on data analysis techniques and applications approaches are important. Users which are currently

operational will need ongoing support, especially as new technical developments (e.g., the Thematic Mapper) are introduced.

Regionally based program.—Landsat technology transfer activities focused on State and local governments should be available on a regional basis because of:

Improved client access to minimize travel costs and time;

Regional geographic differences require that each center emphasize applications of most interest to its region; and

Need for improved regional communications to develop channels between users with similar needs and geography with a goal of eventual self- and inter-reliance.

It is most important that the expertise which NASA has painfully acquired over the last eight years not be lost. The States are also concerned that continuity of technology transfer efforts be maintained during the transition of management responsibilities for the land remote sensing satellite system.

4. Program board

For a number of years, the States have argued for a formal role in national satellite remote sensing policy. If a remote sensing system is to be responsive to the State needs, the States must be involved in the management of the system. The States are a special class of users; they share responsibility for the management of the nation's natural resources with the Federal government. Many of the States' needs for remote sensing data result from Federal mandates and requirements.

The States believe that Presidential Directive NSC-54 was a major step forward, and that the President's intent was to provide for effective State representation on the Program Board. The position of the National Governor's Association (NGA), the National Conference of State Legislatures (NCSL) and the Intergovernmental Science, Engineering and Technology Advisory Panel (ISETAP) is that the Secretary of Commerce appoint a representative of the NGA and the NCSL to the Program Board in at least an ex-officio capacity. The NGA and the NCSL representatives must have all rights and privileges of members except that of voting.

The States also support NOAA's concept of a User Advisory Committee with broad representation from all sectors of the user community. State and local users should be included on the Advisory Committee. Membership on the Advisory Committee, however, is in no way a substitute for State representation on the Program Board.

5. The fully operational system concept

Although it is most difficult to plan a system two generations of technology and ten years in the future, the States' experience with the Landsat 1-3 series enables a broad conceptual outline to be drawn.

States prefer a sensor configuration that would allow for at least 4 bands in the visible and reflected infrared regions of the electromagnetic spectrum, comparable to current MSS bands, but with increased resolution over current MSS capabilities. The preferred system would also include a band in the reflected infrared region sensitive to rock or soil "colors," and at least one band in the thermal or radiated infrared region.

The MSS-type bands plus a thermal channel would be especially useful for applications involving vegetation and water resources.

The preferred configuration would have pointable sensors. Such a sensor would allow for data collection of a shorter repeat cycle. The ability to capture data over a path obscured by cloud cover the previous day, or perhaps anticipated to be covered by clouds the next day, would be advantageous. This capability could also yield pseudo-stereo data, which may be of interest for some State applications.

Operational system concept preferred by the States

Three bands: 30 meter resolution—selected in visible and reflected infrared regions.

One band: 15 meter—preferably in red spectral region.

One band: 30 meter—"rock-sensitive" reflected infrared band.

One band: 30 meter—thermal infrafed.

Recognizing that funding is uncertain for designing and constructing the preferred system, a minimum acceptable system is also outlined. The States' minimum acceptable system would have 4 bands with 30 meter resolution in the visible and reflected infrared regions, comparable to current MSS bands, and one thermal infrared band with 60 meter resolution.

States have expressed a strong desire for data with increased resolution over current MSS resolution and also for a thermal band. If the United States does not implement an operational system with features superior to satellites of other

nations, then the U.S. system would not be competitive internationally or domestically.

6. Data processing system

In the Landsat 1-3 program, delays and uncertainties in getting data through the ground system into the hands of the ultimate users have often precluded use of the data for many applications. The States recommend that the Landsat-D system and the Interim Operational System achieve the following minimum performance standards:

Routine delivery of standard products to users within 7-14 days of satellite observation.

Delivery of selected data in emergency situations within 24-48 hours.

Delivery of data ordered on a retrospective basis within 14 days.

The data processing system should be all digital for both real time and retrospective orders.

The Fully Operational System probably should be designed to meet shorter data handling schedules than are specified above.

7. Standard products

The States agree that the current range of standard MSS digital and film products are basically adequate, and should be extended to TM data and the Interim Operational System. In addition, TM subscenes (perhaps by image quadrants) should be available in a digital format.

The issue of standard map projections and resampling methods for geometrically corrected data should be given very careful consideration. The States recommend that the following projections be available as standard digital products using either Nearest Neighbor or Cubic Convolution processing on request: Transverse Mercator, Lambert Conformal Conic, Space Oblique Mercator/Hotline Oblique Mercator.

By providing several projections as standard products, most users will be able to use the data without further geometric correction. For those users requiring more specialized projections, however, unresampled but radiometrically corrected "raw" data tapes should be available as standard products. Correction coefficients should be calculated and stored in a tape header to assist users in performing their own geometric corrections.

8. Data pricing

The issue of data pricing is one that deeply concerns the States, as decisions on pricing may inadvertantly limit or exclude many State and local government users of satellite data.

In establishing a pricing policy, the States recognize that realization of the Fully Operational System may require that certain costs are recovered. However, no attempt should be made to recover the research and development costs of ongoing experimental programs, nor the major capital costs associated with an operational system. The establishment and operation of a land remote sensing satellite system is viewed as a public service in the same context as census, cartographic, geological and meteorological data which are provided by the Federal government.

If the Federal government adopts a policy of attempting to have State and local governments share in the development and capital costs of a system, it is doubtful that much widespread use of this technology will occur. This technology is young, and high data prices would inhibit the development of operational uses by the States.

The States therefore recommend that the price of Landsat data be limited to the costs of data reproduction, handling and distribution.

9. Data copyright

The States should be able to reproduce the land remote sensing data for their internal use. The States are opposed to any changes in the copyright laws or the Freedom of Information Act that would complicate or restrict access and use of land remote sensing satellite data.

10. Archiving

Historic data are necessary if the States are to be able to make effective policy and program decisions on natural resource management. Because these data are not replaceable, all domestic land remote sensing satellite data should be archived forever if it is relatively cloud free and error free. At a minimum, it is absolutely essential that the States have access to the highest quality (i.e., the most cloud free, error free) scene from each season.

Whatever specific archiving policy is established, it must be clear and consistent. Changes should be made only after extensive consultation with all users and serious consideration of their needs. If changes are to be made or usable data are to be

destroyed. States must be given adequate notice in order to evaluate their long-term needs and acquire the data necessary to meet those needs.

Senator STEVENSON. The subcommittee will come to order.

Our next witnesses are Dr. Allen E. Puckett, chairman of the board, Hughes Aircraft; Mr. John A. Johnson, chairman and chief executive officer of Comsat; C. William Besserer, vice president of TRW; and Mr. Robert Batchelder, vice president of Itek.

I'll invite those four gentlemen to come forward, and also to summarize, if possible, the testimony. Your full statements will be entered in the record. I'm sorry about the interruption, and fear that there's going to be another one, very shortly.

Dr. Puckett?

STATEMENTS OF DR. ALLEN E. PUCKETT, CHAIRMAN OF THE BOARD, HUGHES AIRCRAFT CO.; JOHN A. JOHNSON, CHAIRMAN AND CHIEF EXECUTIVE OFFICER, COMSAT GENERAL CORP.; C. WILLIAM BESSERER, VICE PRESIDENT AND GENERAL MANAGER, SYSTEMS ENGINEERING INTEGRATION DIVISION, DEFENSE AND SPACE SYSTEMS GROUP, TRW; AND ROBERT BATCHELDER, VICE PRESIDENT, ADVANCED PLANNING, OPTICAL SYSTEMS DIVISION, ITEK CORP.

Dr. PUCKETT. Good morning, Mr. Chairman. I am Allen Puckett of Hughes Aircraft. We're pleased to be here with you today. I have submitted a formal statement, but I will take a few minutes here to give you a very brief summary of a couple of the main points.

I think there has been considerable progress in this field of remote sensing in the last several years. One of the important steps that's occurred recently is the action by the President in establishing the goal of eventual operation by the private sector of a remote sensing system. It's this goal of private sector involvement which is, of course, of interest to all of us.

The private sector, of course, is involved today in the development and production of the sensors, the spacecraft, the launch vehicles, the ground processing equipment, and the Landsat system. But the definition of the data products, system design, procurement, and the operation of the equipment, the data processing, are currently performed by various Government agencies.

Further private sector involvement in the land remote sensing business could occur in a variety of ways. I'll mention two or three of these. In one mode, the Government could specify the data products and the services that it desires. The private sector, meaning presumably a private corporation, could procure and operate the equipment, provide data processing, and initial data products distribution to the Government. In this model the Government, in effect, would provide a minimum guaranteed market; it would invite proposals for the supply of the data and the services desired.

So this kind of a procurement would constitute a lease of services. There are some examples of this in the communications satellite field, the Marisat program, the tracking and data relay satellite systems, and so forth. And in this mode—and in my model—the provider of services to the Government would also undertake to sell additional data products or services to customers outside the Government.

In another model, a different approach, this activity, the remote sensing activity, could be placed in a designated corporation, specified or created by congressional legislation. In this case, I would presume that the Government would still constitute a major portion of the marketplace, but would exercise appropriate regulatory control over this designated agency. I suppose a somewhat less analagous example of this mode is the Comsat corporation's role in Intelsat.

Then, in a third mode, the private sector could, if it is a private corporation, could undertake, on a straight risk venture basis, to construct a system to sell the data products as best it could in the commercial market, as well as to the Government. In this mode, the Government might or might not constitute a guaranteed segment of the market.

In trying to analyze these various approaches and to forecast the prospects in each, a very common comparison with the communications satellite experience is made. This comparison must recognize that in the case of satellite communications, the product was quite clearly defined as the transmission of telephone or TV signals or data, and communications satellites were an alternate means for serving an existing worldwide market for a standard product.

I want to draw a sharp distinction here, because satellite land remote sensing is opening an entirely new market, and the product is far from standardized in form and price. The laws of supply and demand haven't really been tested in that market. I think a significant period of market experiment and evolution will be essential before the product will meet the economic test of adequate return on investment in a completely open market situation.

I really don't know how that would work out. Until the market becomes recognizable and quantifiable, an entrepreneur would, I think, find it difficult to project with acceptable risk a return on investment in order to attract the necessary venture capital.

And I might say in addition the legislative, the regulatory, and the tax structures in this country are at present designed to discourage innovation and application of new technologies, if they are high-risk investments, because the rewards simply don't encourage risk taking.

This leads us to the conclusion that in any event for continuation of the system the Government probably must represent the majority of the marketplace, at least for the near future. And there is a need to aggregate and commit this Government market to purchasing data at a fair market price.

That leads us further to the conclusion that the preferred approach is for the Government to contract for satellite data services. This approach would involve the Government's contracting for remote sensing data products from the private sector. This could be done through a contract, a services contract or a lease or whatever you want to call it, awarded after appropriate competition. The contract should specify the data service required by the Government in terms of computer tapes, photographs, processed data, whatever.

In my version of this, as one possible way to do it, the data required would be defined by NOAA in the Department of Commerce, based on input from all appropriate Government agencies.

And the owner and operator of the system which provides the data—that is, the private enterprise—could build excess capacity into system at his own risk. He would be free to market the extra capacity on a noninterference basis to provide service and to develop non-Government markets for the data obtained. So in this approach, the private sector would be encouraged to expand the market, to develop new markets. The Government would provide for aggregating the basic market through the competitive process, presumably obtain the desired service at the best conditions or under the best conditions of the best price for the Government.

And so, just to summarize that, specifically, a single Government agency would coordinate the government remote sensing data requirements and funding. And NOAA, we think, is an appropriate choice. NOAA would accumulate all the appropriate Government requirements. And then, through a normal procurement process and request for proposal, invite industry proposals for privately establishing this remote sensing system. And the Government would agree to contract for data services of this system at a specified level for a given period of time.

Then, just a couple of other points I will summarize here. I think that with respect to use by foreign nations, direct transmission to foreign ground stations or data sales to foreign markets could be accommodated either under clauses in the Government service contract—that would be a government-to-government arrangement—or directly by the system owner and operator, in this case, I would presume, under some sort of government regulation and control.

Then, a last point here, which I think is pretty crucial, the term of the contract would be such that the Government would be assured of data continuity on the one hand and would have known long-term funding requirements; and on the other hand, the system owner and operator would be provided with a known market base.

Just a couple of final comments here. With respect to the so-called "legislative" approach, the approach in which the Government might create or designate a particular Government agency as a chosen instrument, I think there are several drawbacks to that. The first of them, pretty obvious: Competition would, I think, be unnecessarily curtailed. Secondly, the service contract arrangement, I think, would provide a lot more flexibility in accommodating the rapidly changing requirements and business developments. I won't elaborate on it any more in my present statement.

The question arises: When could a privately operated system be in place? Well, Landsat D and D' which are now in the national program, should be in operation until about 1984 and maybe longer. In order to avoid an interruption of the Landsat data, I think it would be prudent to proceed through NOAA with the procurement of an interim system of at least two more Landsat D class spacecraft which would ensure Landsat data continuity through the mid-1980's, 1985, 1986. At this point, I think the private system as a privately owned system could reasonably be expected to phase into operation if the necessary steps were taken in the fairly near future.

That is, it would be important to begin to define within the next year or so the aggregated data needs of the Government as they might exist in this 1995-96 time period, and begin to take steps to

initiate a dialog with industry to formulate the kind of contractual arrangements that would be appropriate and thereby to lead up to the issuing of a request for proposal and the negotiation of the contract.

So, Mr. Chairman, that's a very brief summary of a couple of the points that I have made. I appreciate your inviting us here. And I will be glad to answer questions now or later.

[The statement follows:]

STATEMENT OF DR. ALLEN E. PUCKETT, CHAIRMAN OF THE BOARD, HUGHES AIRCRAFT CO.

Mr. Chairman and Members of the Committee, I am pleased to have the opportunity to speak to you this morning on behalf of the Hughes Aircraft Company regarding the role of the private sector in an operational space-based earth resources remote sensing system.

I am especially pleased because it was only two or three years ago that the whole issue of an operational civil land remote sensing system was still very much in doubt. Today, due in no small part to the efforts of several Congressional Committees, the United States has committed to an operational system. The President, through Presidential Directive 54 (PD54) has taken a very important step in this regard. He has placed management responsibility for the operational civil land remote sensing activities within a single Government agency, National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce. Furthermore, the President has established the goal of eventual operation by the private sector of these remote sensing activities.

It is this goal of the private sector involvement which is of interest to all of us. The private sector, of course, is involved today in the development and production of the sensors, the spacecraft, the launch vehicles, the earth stations, and the ground data processing equipments for the Landsat system. The definition of the data products, the system design, the procurement and operation of the equipments, the data processing and data products distribution are currently performed by various Government agencies. A small, but important, private sector activity in the form of new separate companies and new organizations within existing companies has developed to perform value-added analysis on these Landsat data products. Certain Government organizations like the Department of Agriculture, Department of Interior, and others also perform value-added analyses on these data products in order to carry out their responsibilities. There is increasing evidence that the information derived from the Landsat data products does provide valuable benefits to a broad spectrum of organizations in the United States and throughout the world.

Further private sector involvement in the operational land remote sensing activities could occur in a variety of ways. In one mode the Government would specify the data products and services which it desires. The private sector would procure and operate the equipment, provide data processing, and initial data products distribution to the Government. The Government, in effect, provides a minimum guaranteed market, and would invite proposals for the supply of the data and services desired. This procurement would constitute a lease of services. Examples of this mode in the communication satellite field are the Marisat, Tracking and Data Relay Satellite System (TDRSS), and Leasat. In this mode the provider of services to the Government could also undertake to sell additional data products or services to customers outside the Government.

In another mode, the activity could be placed in a designated corporation specified by Congressional legislation. In this case, the Government would still constitute a major portion of the marketplace, but would exercise appropriate regulatory control over the designated agency. A somewhat less analogous example of this mode is the Comsat Corporation's role in Intelsat. This mode could be called the "legislative" approach.

In a third mode, the private sector could undertake on a risk venture basis to construct a system and to sell the data products as best it could in the commercial market, as well as to the Government. In this mode, the Government might or might not constitute a guaranteed segment of the market.

Involving the private sector in land remote sensing activity in any of these modes does raise some general questions. Can the private sector really participate in the operation of a civil land remote sensing system? There is little question that the private sector can build and operate such a system. I think that we will all agree that there remains a serious question whether the data products from such a system

could be sold in the open marketplace at a price which would provide an adequate return on the required investment to construct and operate the system.

Is the private sector willing to participate? For the approach I previously defined as the "legislative" approach, willingness is not required because the Government could create or designate a quasi-Government entity to perform all the activities. For the "leasing" approach there is evidence from the communications satellite field that the answer is "yes". However, the financial, technological, operational, and market risks now borne by the Government in the Landsat system must in some manner be adequately accounted for and accommodated, if these risks are to be transferred to the private sector. Domestic and foreign policy implementation could limit how the private sector can participate in the areas of sensing and data distribution, but these limitations need not be insurmountable. The general principle which will determine the timing and degree of participation by the private sector will be very simply the recognition of an opportunity to make a sound investment with a reasonable opportunity for return. This will come about as specific users or customers become more aware of real financial benefit from using the system, and are in turn prepared to buy the product at a reasonable price.

A comparison with the communications satellite experience is often made. This comparison must recognize that in the case of satellite communications the product was quite clearly defined—transmission of telephone or TV signals—and communications satellites are an alternative means for serving an existing worldwide market for a standard product. Satellite land remote sensing is opening an entirely new market and the product is far from standarized in form or price. A significant period of market experiment and evolution will be essential before the product will meet the economic test of adequate return on investment. Until the market becomes recognizable and quantifiable, the entrepreneur may find it difficult to project with acceptable risk the return on investment that he can achieve in order for the financial institutions of this country to provide venture capital. In addition, the legislative, regulative, and tax structure in this country at present discourages innovation and application of new technologies if they are high risk investments because the rewards do not encourage risk-taking. This is an endemic problem, recognized to be inhibiting advances in many areas. Changes in this climate are not likely to come quickly. Again, these obstacles need not be insurmountable. However, it will require that industry and Government work together in a very determined fashion.

Are the major issues well identified? Are they tractable? The following fundamental issues exist which must be addressed.

It must be accepted that the Government will represent the majority of the marketplace, at least for the near future. There is need to aggregate and commit this market to purchasing data at a fair market price.

Clarification of Government and industry roles in remote sensing is required to preclude Government competition with the private sector.

Private investment incentives are required.

Market development incentives are required.

The degree of Government regulation of remote sensing by a private entity must be determined.

International sensitivities regarding data acquisition and distribution methods by a private entity must be clarified.

There is steadily increasing foreign competition in the area of remote sensing. The degree to which the United States will cooperate or compete with foreign systems must be determined.

A realistic plan must be established for transition from Government to private ownership and/or operation of a remote sensing system.

Requirements of special or "public user" groups must be satisfied.

Is there a recommended approach? The preponderance of opinion these days seems to favor either of two approaches: a legislative or "quasi-Governmental" approach, or a so-called "lease" or satellite data services approach. The preferred approach, in my opinion, is for the Government to contract for satellite data services.

This approach would involve the Government's contracting for remote sensing services and/or data products from the private sector. The contract would be awarded after appropriate competition. Such contracts would specify the data service required by the Government in terms of computer tapes, photographs, processed, or preprocessed data. The data required would be defined by NOAA (Department of Commerce, National Oceanic and Atmospheric Administration) based upon input from all appropriate Government agencies. The owner/operator of the system which provides the required data could build excess capacity into the system at his own risk. He would be free to market the extra capacity on a non-interference basis to

provide service and to develop non-Government markets for the data obtained. This approach would encourage private sector participation in expanding the market for land remote sensing data products. The Government would provide for aggregating the basic market and, through the competitive process, would obtain the desired services at the best conditions for the Government.

Specifically:

A single Government agency would coordinate Government remote sensing data requirements and funding. NOAA, with their background in operational meteorological satellites, is an appropriate choice to perform this function.

NOAA would accumulate all appropriate Government requirements and then, by Request for Proposal, invite industry proposals for privately establishing and operating a remote sensing system which would provide at least the required capacity and characteristics to fulfill specified Government needs. The Government would agree to contract for data services of this system at a specified level for a given period of time.

The system to provide this service would consist of all space-based sensing and data transmission hardware, ground receiving stations, ground data processing and archiving facilities, and data relay systems required to provide necessary services.

Services and data products could include direct data relay or conventional forwarding (mail, cargo, etc.) of High Density Data Tapes (HDDTs), raw or corrected Computer Compatible Tapes (CCTs), and photographic products.

The system owner and operator would be free to build excess capacity and capability into his system with which he could, on a non-interference basis, develop the non-Government market.

The system owner and operator could be constrained from certain value-added services. This protects the existing industry base and encourages growth in the value-added data processing industry.

Direct transmission to foreign ground stations or data sales to foreign markets could be accommodated either under clauses in the Government service contract (Government-to-Government) or directly by the system owner and operator under Government regulation and control.

The term of the contract would be such that the Government would be assured of data continuity and have known Long-term funding requirements. The system owner and operator would be provided a known market base.

Government regulation system should be limited to such things as preservation of competition, pricing policies, and equitable data accessibility.

The approach broadly sketched above is neither new nor novel. Numerous examples may be given, particularly in the communications field where Government has found it beneficial to enter into service arranagements with industry. In many cases, these same examples serve to illustrate the capability and willingness of industry, using private financing, to assume or extend functions and services initially provided by the Government, and to initiate new services as soon as commercial viability is established. The sizable private investment required by many of these ventures is also such that industrial teaming arrangements are attractive. Thus, broad industry participation is encouraged. I again emphasize that the degree of risk transfered from the government to the private sector must be accounted for and accommodated in this approach.

The so-called "legislative" approach has several drawbacks. First, competition is curtailed unnecessarily. TDRSS and Leasat, among others, indicate strongly that sufficient industry interest will exist to ensure a good competition when an appropriate business climate exists. Second, a contractual arrangement would permit much more flexibility in accommodating rapidly changing requirements and business climate. Government charter modifications requiring prolonged legislative actions are, in general, not compatible with a fast moving technology and rapidly changing marketplace as operational land remote sensing is likely to be for the foreseeable future. A good example of this is the turmoil in initiating the U.S. domestic communications satellite systems resulting in part from the Communications Act of 1962 which failed to anticipate the rapid growth of satellite communications. Third, a potentially unregulated monopoly or "dominant carrier" would be established. For instance, when Comsat was established the FCC was in existence to regulate it as a monopoly. There is no "FCC" for remote sensing.

When could a privately operated system be in place? Landsat D and D' will be in operation until about mid-1984. In order to avoid an interruption of Landsat data like the current threat, it would be prudent to proceed through NOAA with the procurement of an "interim" system of at least two more Landsat D class spacecraft which would be required to ensure Landsat data continuity through the mid-1980's. It would be at this point that a private system could reasonably be expected to

phase into operation. NOAA is a good choice to oversee this transition, with their operational experience and orientation toward applications of remotely sensed data.

As you can see, Mr. Chairman, my brief remarks reflect a mixture of optimism and restraint; of encouragement and caution. The remarks above were made to both reflect a viewpoint and to stimulate discussion of major issues. I would be pleased to respond to any questions the Committee might have. Thank you.

[The following information was subsequently received for the record:]

QUESTIONS OF THE COMMITTEE AND THE ANSWERS THERETO

Question. There has been expressed a concern that private sector operated remote sensing systems might not be responsive to the needs of state and local governments and possibly other small users of such data, or that their requirements would be ignored in favor of large industrial firms or other customers with a greater "ability to pay". How do you envision these concerns would be addressed by the private sector?

Answer. I agree that there might be a legitimate concern regarding the degree to which a private sector operated remote sensing system would be responsive to the needs of state and local governments. One way to address this problem might be to incorporate the state and local needs with the federal government requirements for service and, in effect, to cause the federal government to subsidize the data needs of state and local governments. The data required by state and local governments will probably be quite similar to that required by the federal government, so as far as raw data is concerned no particular special provisions or additional costs are likely.

Question. How can other nations be prevented from using the data from the U.S. system to make inroads into the market by offering more attractive terms for this data?

Answer. It is necessary to distinguish between raw data and processed data or information which might be derived from the raw data. I would presume that other nations using data from the U.S. system would do so on the basis of some contractual arrangements which would provide adequate compensation to the system owner, and would also include restrictions on its further use.

Question. How should the government provide for the civil land remote sensing system to be integrated into military operations during national emergencies if the civil system is in the private sector?

Answer. I see no obvious requirements for the civil land remote sensing system to be integrated into military operations during national emergencies—the military systems should provide all information required for that purpose. However, if for some reason the civil system data were useful to the military this could be arranged in the same way that civil air transport or other civil utilities have supported the military in times of emergency.

Question. Do you see any problem in transferring to private sector managment of the operational system government technology—that is remote sensing technology developed under government auspices?

Answer. I see no problem with respect to technology transfer. The technology required for remote sensing resides primarily in the private sector already, even though it may have been developed under government auspices.

Question. Are joint ventures between government and industry a practical approach to operating a land sensing system? What areas or roles should be considered for industry?

Answer. It seems to me that a joint venture between government and industry is very unlikely to offer any advantages in the operation of a remote sensing system.

QUESTIONS OF SENATOR HEFLIN AND THE ANSWERS THERETO

Question. Is there a substantial commercial market for land remote sensing data and interpretive service? Have adequate analyses of present and future commercial and government markets been made? Should the government define the performance and physical characteristics of an operational land remote sensing system or should industry?

Answer. There is undoubtedly a commercial market for land remote sensing data, but the size of this market, and the price sensitivity has certainly not been determined. There have been numerous analyses of present and future commercial and government markets, which are not as definitive as we might prefer, but are probably about as accurate as present knowledge permits.

The government should define the performance of an operational system insofar as its own requirements are concerned, but should not define the physical characteristics. Industry can then define through the design process the physical characteristics of the system and might, in fact, include additional performance features not required by the government but of potential value in developing a commerical market.

Question. What considerations of foreign competition are involved in the question of private sector participation in an operational remote sensing system?

Answer. Foreign competition is probably not a primary consideration in the question of private sector participation in an operational remote sensing system. At the present time it is probable that the European community will expand their activities in remote sensing, but in the form of a completely government-sponsored enterprise.

Question. What effect would existing government facilities such as the EROS Data Center have on private sector ownership of the operational system, and should the government divest itself of such facilities? What effect does the present of the many foreign Landsat ground stations have on your thinking?

Answer. The existing government facilities could continue to be owned and operated by the government even if the space segment of the operational system were owned and operated by the private sector. However, this would require careful agreement regarding use and distribution of data processed for example, by the EROS Data Center, in order to avoid competition with the private sector. In the long run, it would probably be desirable for at least some of the government facilities to be transferred to private ownership, or alternatively, to be operated by the private owner of the space segment.

The existence of foreign Landsat ground stations simply indicates to me the foreign market for data, and on opportunity to negotiate reasonable terms for the use of such data.

Question. How should the government assure the private sector that it will not compete in areas where private sector initiatives in land remote sensing take place?

Answer. There is no simple to this question except to say that such assurances most certainly would be required. A description of the limitations on government activity would require some study and negotiation, but should not fundamentally be difficult.

Question. Are there any exclusive rights required to enable practical participation by a private sector entity in an operational land remote sensing system?

Answer. A private sector entity would certainly require some definition of its rights in order to enable practical participation in an operational system. The question of what rights might be exclusive and what rights might be shared is obviously a matter of negotiation.

Question. Is legislation needed to encourage private sector participation in an operational remote sensing system? What do you see as the nature of the government's financial supports required in this area in the various stages of evaluation of an operational land remote sensing system?

Answer. It is probable that legislation is required in order to permit and to specify the nature of private sector participation in an operational system. The model which I have described would provide government financial support in the form of a contract for supply of certain well-defined data. The approximate cost of such data would be estimated in discussions and negotiations between government and contractors in a stage prior to the final definition of data requirements.

Question. What involvement should the private sector have in the transition from the present experimental Landsat system to a fully operational land remote sensing system? Does the question of private sector participation in an operational land remote sensing system need to be studied further? If so, who should sponsor and who should conduct such studies? What mechanisms should be set up to provide for industry inputs to the government now and during the period of transition? What kind of financial incentives should the government provide to promote sector involvement and do you feel that you could depend on government commitments?

Answer. My recommended approach to private sector involvement in an operational remote sensing system is pretty well described in my testimony. It would be desirable to explore this approach further and in more detail, and NOAA is probably an appropriate agency to conduct such studies. The mechanism for industry input would simply be the action by NOAA to initiate dialogue with industry regarding the trade-offs between types of data, quantity of data and cost of supplying data.

The financial incentives for industry participation are inherent in the bids which industry might make to provide data in response to government requirements.

Obviously, we would rely on government commitments when they are adequately set forth in a contractual document.

Senator STEVENSON. Thank you, Dr. Puckett. I think we'll continue and have questions after all the statements.

Mr. Johnson.

Mr. JOHNSON. Thank you, Mr. Chairman.

In my prepared statement, I have endeavored to set forth a specific procedure which we believe will enable a private owner-operator to make the necessary investment and take over the total responsibility operationally for a remote sensing system by the period 1985–86.

I would like to say, before I summarize my statement, that there are some things in the NOAA document that concern us very seriously and which we think are somewhat misleading as they relate to the prospect for private ownership and operation. The document refers to an "interim operational system" which is described as a system to follow after the presently programed Landsat-D and D' satellites in the 1985–86 time period, and which presumably would be operational until about 1989, at which time a system called in the document a "fully operational system" would come into operation.

We think those terms are not very accurate and really are somewhat misleading. They carry the unfortunate implication of somehow suggesting that the system is not fully ripe for a private sector involvement until 1989.

As we understand it, the transition plan does envisage, as NASA's own program does, the launch of Landsat-D in about mid-1982 and the launch of D' sometime in 1983. Those are both expected to be 3-year lifetime satellites, which takes the operational period of those satellites to about 1985 or 1986.

We also understand that during the period of about 1982 to 1984 there will be a series of transitional actions which will pass the responsibility for operating those satellites in the system on to NOAA. With all that, we agree. It really isn't our business to question the realism or the usefulness of that kind of proposal. But we do feel that just as soon as NOAA takes over, it must be regarded as an "operational" system. That's the difference between NASA and NOAA: NASA is an agency responsible for experimental and developmental work, advancing the state of the art; NOAA is an operating agency. So far as we're concerned, from the moment that NOAA takes over the responsibility for Landsat-D and D', we have an operational system.

The only reason given for calling this thing that is expected to begin in 1989 a fully operational system is that the document says there are certain desirable technological innovations and advances that might be accomplished between now and then which would enable us for the first time in 1989 to have a system that does all the things that everybody wants to do.

I don't really think that's the test of an operational system. The test of an operational system is whether it's being operated for practical benefit, which I assume is the case as soon as NOAA takes over the operating responsibility.

Now, we have suggested specifically a procedure which we think is workable and in keeping with announced Government policies. It is consistent with the OMB circular which describes certain crite-

ria for testing the validity and advantage to the Government of a proposal from the private sector, and also with the President's policy statement of last year.

Specifically, Mr. Chairman, we propose that NOAA, together with other interested Federal agencies, define the total requirements of all Government departments and agencies for data derivable from a civilian remote sensing system operating during the period 1985–86 to 1989–90, following Landsat-D and D′. This is the period described as the "interim operational system" in the NOAA document, and it is the period for which NOAA proposes that they procure additional satellites and operate them as Government-owned satellites in an operational system.

Our second step is to determine the true total cost to the Government of obtaining such data by means of a Government-owned system during the period that I have mentioned, 1985–90 or 1986–89, whatever that may turn out to be, depending upon the actual launch dates of Landsats-D and D′ in 1982 and 1983; then, make the data requirements and the cost estimates available to the private sector by March 30, 1981. We've set forth a timetable because we're trying to be just as precise as possible, Mr. Chairman. The next step would be to invite proposals from the private sector to be submitted by January 31, 1982, to meet the defined Government requirements for the period of the so-called "interim operational system."

During those months, between March 1981 and January 1982 those of us who would expect to be responsive to such a request for proposals would be doing all of the necessary analysis and forecasting for the development of the non-Government market, so that we can determine to what extent we'd be able to provide savings to the Government by relying upon the nongovernmental users for a significant portion of our revenue requirements.

And then, as the final step, the Government—NOAA, presumably—would evaluate the private sector proposals in accordance with the cost comparison policies which are presently set forth in OMB's circular A–76. We're proposing that that could be done in some 5 or 6 months, and that by mid-1982 a contract could be awarded. The duration of that contract, whether it should be a contract for 3, 4, or 5 years or whether it should be a longer period of up to 10 years, is something that we have an open mind about and which we would expect NOAA to address.

Now, this procedure would enable interested companies to take into account in preparing their proposals the potential revenues which they might derive from all users of data other than the U.S. Government. Potential bidders would have to make a significant investment in the accomplishing of market tests and the preparation of a system design which would take into account the needs of both Government and non-Government users.

We anticipate that this process could be completed by mid-1982, in time for a 1985–86 launch of the first satellite of a privately owned and operated civilian remote sensing satellite system. That is, we are proposing a period of approximately 3 to 3½ years from the award of the contract to going fully operational with the satellites that we would use to perform that contract.

During this 3- to 4-year period, we would also envisage a close working relationship with both NOAA and NASA to pursue our mutual interests.

In my prepared statement, we have suggested some of the things that we might be doing in collaboration with NOAA and NASA to further our mutual interests. I do regard our interests as being mutual. The Government has a desire to obtain a certain amount of data of a certain kind at the lowest possible price. It would be in their interest as well as ours to collaborate in developing the potential market and certain pricing policies.

We pointed out in the prepared statement that this procedure would not preclude any of the options for eventual institutional arrangements that are set forth in the NOAA documents. That is, if it turned out by mid-1982 that there was no private owner-operator able to make an attractive proposal to Government which stood up under the analytical and comparative procedures set forth in OMB circular A-76, then one of the other options mentioned in the NOAA document could be pursued. There would have been no loss of time in the interim because those options do not envisage any private involvement until about 1989, in any event. So, mid-1982 would be adequate time to address the other options if this one, which NOAA itself says is the one most likely to achieve rapid involvement of the private sector, should fail for lack of an adequate and desirable response.

It's obvious, of course, that we support option one, as set forth in the transition plan, and strongly oppose each of the other options. We're prepared to answer any questions along that line, Mr. Chairman, but we think that all the other options would probably effectively preclude any significant private investment in operational systems.

I think, Mr. Chairman, that that is a sufficient introduction of our own views on this, and since you have my statement, I think it would save time if I didn't read it in its entirety. Thank you, Mr. Chairman.

[The statement follows:]

STATEMENT OF JOHN A. JOHNSON, CHAIRMAN AND CHIEF EXECUTIVE OFFICER, COMSAT GENERAL CORP.

I am pleased to appear before you today to propose an opportunity for Government and industry cooperation and innovation by creating a procedure for a competitive selection of a private owner-operator of a civilian remote sensing system to begin operation in 1985-86 when the Landsat-D satellite may be going out of service. This procedure would enable potential investors to demonstrate the efficiency and Federal Government cost savings which can be realized by private ownership and operation of a civilian remote sensing system beginning in 1985-86.

Specifically, we propose that NOAA, together with the other interested Federal agencies:

Define the total requirements of all Government departments and agencies for data derivable from a civilian remote sensing system operating during the period 1985-86 to 1989-90 following Landsat-D and D prime;

Determine the true total cost to the Government of obtaining such data by means of a Government owned system during the period 1985-86 to 1989-90; (i.e., the true total cost of establishing and operating the system described as the "Interim Operational System" in the NOAA Transition Plan);

Make the data requirements and the cost estimates available by March 31, 1981, and invite proposals from the private sector to be submitted by January 1, 1982, to meet the defined Government requirements for the period 1985-86 to 1989-90;

Evaluate the private sector proposals in accordance with the cost comparison policies contained in OMB Circular A-76 and, by June 1982, award a contract accordingly.

This procedure would enable interested companies to take into account, in preparing their proposals, the potential revenues which they might derive from all users of data other than the U.S. Government. Potential bidders would have to make a significant investment in the conduct of market test and the preparation of a system design which would take into account the needs of both Government and non-Government users. We anticipate that this process could be completed by mid-1982, in time for a 1985–86 launch of the first satellite of a privately owned and operated civilian remote sensing satellite system.

After the award of a contract to provide remotely sensed products to the Government, we envision with the private owner-operator entering into a close working relationship with NOAA and NASA during the operational lifetimes of Landsat-D and Landsat-D prime.

For example, management and operational personnel supplied by the owner-operator could begin to work with NASA and NOAA in a timely manner to obtain hands-on experience. The private owner-operator could work closely with NOAA in developing the pricing policy to be employed prior to the initiation of the privately commercial system. NOAA, NASA, and the owner-operator could begin to plan for the modification and transition of the ground processing to the facilities of the private owner-operator. Furthermore, the owner-operator through an appropriate contractual arrangement with NOAA could become involved in the development of the domestic and international market for remotely sensed products and services, thus potentially the revenue to the Government prior to the initiation of a privately owned commercial system in 1985–86.

The procedure we are proposing would not foreclose any of the options for the establishment of an operational remote sensing satellite system an enunciated in the Transition Plan. While the task of defining the Government's data requirements and computing a true total cost of a Government owned and operated system capable of satisfying those requirements will require the expenditure of a modest sum of money, this task can be accomplished by the present NOAA staff with contract support and with help from NASA and other agencies, and it is a task which needs to be done as soon as possible, regardless of the option chosen.

In the event that the bids from interested companies would not result in any economies to the Government according to the standards established by OMB Circular A-76, the Government would be free to proceed with one of the other options without a loss of either time or money. The basic risk would be assumed by those companies submitting bids, since there is no assurance that the money spent in market analysis and system design would ever be recovered.

On the other hand, if this procedure results in award of a contract to a private owner-operator in 1982, significant benefits would accrue to the Government.

First, and foremost, the process of reducing the net cost to the Government of acquiring data would begin immediately upon the award of a contract and data continuity would be assured.

Second, significant economies could be achieved within NOAA. NOAA would be relieved of the need to hire additional personnel to manage and operate the system and would be relieved of the need to procure additional ground processing equipment for installation at NASA's Goddard Space Flight Center which may be incompatible with or duplicative of commercial facilities. The need for major consulting contracts for pricing studies would be reduced or eliminated and the need for NOAA to hire marketing personnel and mount a sales campaign could be satisfied by using the owner-operator under a cost reimbursable or other mutually satisfactory arrangement.

Obviously, COMSAT General supports "Option 1" as set forth in the Transition Plan, i.e., the competitive selection of a private corporation or consortium to own and operate the post Landsat-D prime system. We agree with the "attributes" of this option as set forth in the Transition Plan (pp. 68–69), e.g., (1) the private entitly would own and manage the system; (2) private capital would be used to develop and build the system; (3) a portion of the system's revenues could be provided by a multi-year Federal contract for data meeting Government requirements; (4) the private owner-operator would assume the risk of market development (and innovation) to meet its additional revenue requirements; and (5) NOAA would be responsible for ensuring compliance by the owner-operator with U.S. policies.

Although we agree with NOAA's general framework for Option 1, we disagree with NOAA's apparent assumption that Government must, throughout this decade, own and operate an "Interim" and then develop a "Fully Operational" system which might be offered to the private sector as a "turnkey" system. The problems

with this underlying "turnkey" approach are many, but the most fundamental is that we may arrive in 1989 or 1990—after very substantial Government investments and personnel costs (the Plan mentions $100-200 million per year)—with a system that is inherently unattractive to private capital investment. Furthermore, as I understand the Plan, the prospective turnkey owner-operator would arrive on the scene prepared for operational responsibility only by prior advisory participation or ad hoc involvement in the transitional process. It would appear that a "turnkey" approach would would work to inhibit rather than promote the transfer of remote sensing to the private sector and should be discarded as inconsistent with the goals of Presidential Directive 54.

We propose instead to create an opportunity for Government industry innovation and cooperation that is increasingly recognized as necessary for the maintenance and successful growth of our economy. We propose to achieve the overwhelming benefits which can be accomplished by private ownership and operation of a remote sensing system (Option 1). Some of the benefits of Option 1 which were recognized in NOAA's Transition Plan are:

1. achievement of the goal of private sector ownership and operation at the earliest possible time;

2. placement of financial and operational risks in the private sector:

3. deferral of Federal outlays for data by using a multi-year data purchase contract;

4. ensure compliance of the activities of the owner-operator with U.S. policy by contract with NOAA;

5. responsiveness by the private owner-operator to market demands by expenditure of more resources on development of new products and services.

At the same time, Option 1 also achieves the relevant benefits of establishing a new remote sensing corporation (Option 2) but has none of the costs and uncertainties associated with establishing a new corporation.

In addition to those benefits listed by NOAA, our approach offers the specific opportunity to achieve early private capital and human resource investment in remote sensing development and the concomitant net reduction and phasing of Federal outlays. Our approach involves the private sector in doing what it does best, while protecting the public interest. It provides the framework to achieve a desirable degree of cooperation with the emerging remote sensing systems of other nations and the global remotely sensed data user community. Furthermore, our approach is consistent with the principles of a competitive economy and with the achievement of all the goals stated in Presidential Directive 54.

While our purpose today is not to address the Transition Plan's many specific issues, options and assumptions, I would like to comment on three key topics raised in the Plan. First, NOAA's repeated assertion that a transfer to the private sector cannot be effected any earlier than 1989 simply is not supported in the Plan on technical, institutional, or practical grounds. It can be justified only on the a priori assumption that a turnkey approach with all its accompanying problems is the only real option worthy of consideration. I trust that our proposals today demonstrate that this is not the case.

Second, I believe that Option 3, a Government corporation, and Option 4, Federal agency ownership, simply defer—perhaps into the next century—the necessary commitment to the goal of private sector investment, ownership, and management of remote sensing systems. Serious consideration of either of these options simply dilutes the energy and innovation needed to make Presidential Directive 54 work. If the Government elects to proceed with either Option 3 or 4, I believe that the resulting delay will cause potential private sector investors to look elsewhere for investment opportunities.

Third, I believe that our Government and the private sector can proceed almost immediately along the lines we are proposing and that the myriad issues and options should not deter us from beginning the required effort. If the commitment is made to make the procedure work, there is no need to address every possible issue before making a beginning.

It is our opinion that some form of Congressional direction is required to get this procedure started. Congress should require NOAA to prepare an analysis and define the data requirements of the Government for post Landsat-D (1985-86 to 1988-89) and determine the true total cost of establishing and operating a Government system which could provide sucdh data. Congress should require the data requirements and cost estimate to be prepared and made public as part of a request for proposals by March 31, 1981. Congress should grant NOAA the requisite authority to enter into contracts on behalf of all U.S. Government agencies for the procurement of remote sensing products and require NOAA to procure such products from the private sector unless the NOAA analysis described above shows total cost

savings associated with an in-house effort as required by the policies and standards set forth in OMB Circular A-76. If Congress acts quickly to set this procedure in motion, we believe that a privately owned and operated remote sensing system can be established by 1985–1986.

[The following information was subsequently received for the record:]

QUESTIONS OF THE COMMITTEE AND THE ANSWERS THERETO

Question. There has been expressed a concern that private sector operated remote sensing systems might not be responsive to the needs of state and local governments and possibly other small users of such data or that their requirements would be ignored in favor of large industrial firms or other customers with a greater "ability to pay." How do you envision these concerns would be addressed by the private sector?

Answer. COMSAT General is very mindful of the requirements of the state and local governments since they represent a significant market for remote sensing data. The need to assure the commercial success of the venture would motivate any private owner-operator to be responsive to the state and local governments and further develop those markets. COMSAT General would fulfill every data need which could possibly be satisifed on a commercial basis.

However, to the extent that state and local governments have unique data requirements that can be satisified only by expensive system modification or additions, then those needs should be taken into account by NOAA during the data definition phase of the procurement process we proposed in our testimony. Such data would be procured by the U.S. Government on behalf of the state and local governments as part of the data package provided under contract.

Question. How can other nations be prevented from using the data from the U.S. system to make inroads into the market by offering more attractive terms for the data?

Answer. Foreign ground stations would receive direct readout of data from a private U.S. system under a licensing or royalty type commercial arrangement which would compensate the system operator for all data copied and distributed. Violation of these terms could result in the foreign ground station being cut off from direct readout by changing the key to the encrypted data stream from the satellite.

Question. How should the Government provide for the civil land remote sensing system to be integrated into military operations during national emergencies if the civil system is in the private sector?

Answer. Section 606 of the Communications Act of 1934 establishes emergency powers of the President of the United States over interstate and foreign communications facilities in times of war and other national emergencies. This section of the Communications Act sets forth the conditions under which the President may exercise those powers and a method for compensating the owners of the communications facilities for any use or control by the Government of said facilities. Furthermore, we would anticipate that any contract between the Government and a private owner-operator would provide for special operating procedures in times of national emergency. Therefore, we believe the Government would have adequate control over a privately owned and operated system in times of national emergency.

Question. Do you see any problem in transferring to private sector management of the operational system Government technology—that is, remote sensing technology developed under Government auspices?

Answer. We do not foresee any problem in transferring such technology to the private sector. There are numerous precedents for the successful transfer of technology developed under Government auspices to private sector applications.

Question. Are joint ventures between Government and industry a practical approach to operating a land remote sensing system? What areas or roles should be considered for industry?

Answer. We do not believe that a joint venture between Government and industry would be a practical or desirable approach to operating a land remote sensing system. The long-range benefits to the United States of commercially developing remote sensing would be best achieved by operation of a land remote sensing system in a profitable and businesslike manner. Therefore, it follows that the system should be owned and operated by private commercial interests. Furthermore, since all public interests objectives of the Government can be accomplished by the terms and conditions of a data procurement contract with the private owner-operator, there is

no need for the Government to be involved in the joint ownership and management of an operational system.

QUESTIONS OF SENATOR HEFLIN AND THE ANSWERS THERETO

Question. Is there a substantial commercial market for land remote sensing data and interpretive services? Have adequate analyses of present and future commercial and Government markets been made?

Answer. We believe there is potentially substantial global commercial market for land remote sensing data and interpretive services. However, this market is still largely latent and considerable effort must be expended to develop it sufficiently so that it would support a viable and profitable commercial venture. This will only come as new products and applications of existing products, tailored to commercial requirements, are developed. This situation makes definitive market surveys to quantify both the Government and commercial marketplace nearly impossible today. Government is the most mature "market" for remote sensing data today and in the foreseeable future, but we believe that a private entity is the only logical choice to aggressively develop the commercial marketplace.

Since most of the markets have evolved as a result of the Government providing data at little or no cost, and the Government itself has not instituted a successful market development program, the commercial use and application of land remote sensing data are evolving slowly. One exception to this is the petro-mining industry which has expressed its views on this matter through the GEOSAT Committee. Other commercial applications, such as forest inventory, engineering, and mapping, have been constrained by both the design and research emphasis of the Landsat series. Under appropriate margins of risk, we believe industry will enter these marketplaces and develop them actively. This is the only way "adequate analyses" can be performed; paper studies simply cannot substitute for the market presence of a private owner-operator dedicated to achieving a commercial success.

Question. Should the Government define the performance and physical characteristics of an operational land remote sensing system or should industry?

We believe that the Government should define the data which it requires and industry should design the system which would meet those requirements and any additional requirements which would make the system commercially attractive. For example, the requirements of the Government for the 1985–1988 time frame should be expressed in terms of resolution, spectral band and bandwidth, ground point accuracy, and repetition of coverage. It should be the responsibility of the bidder to decide most cost effective system by which that data would be produced and delivered.

Question. What considerations of foreign competition are involved in the question of private sector participation in an operational remote sensing system?

Answer. A private sector venture must seriously consider competition from foreign owned and operated systems because foreign competition will probably be underwritten by foreign government treasuries. The advantages that the U.S. has in technology, applications, and business delivery in some cases may offset the advantage of a lower price offered by a foreign competitor. Nevertheless, we would expect the U.S. Government to provide a remote sensing business the same support and protection afforded other U.S. businesses which have to compete with subsidized products in U.S. and international markets.

Question. What effect would existing Government facilities, such as EROS Data Center, have on private sector ownership of the operational system, and should the Government divest itself of such facilities?

Answer. The existing ground facilites owned and operated by the Government were designed and presently operate for the purpose of furthering the research and development activities of NASA and their prinicpal investigators. Many of these Government facilities may be of future value to the Government in its continuing research and development activities and, therefore, should remain within the Government for use in continued advance research.

In general, we feel that the data processing facilities currently owned and operated by the Government would not be commercially useful to a private sector owner-operator and are not necessary ingredients for encouraging private sector investment. Furthermore, we feel that it would be unwise for the Government to invest significant additional resources in new facilities or equipment for an operational system since a transition to the private sector is anticipated.

With regard to the EROS Data Center in Sioux Falls, South Dakota, it is our understanding that NOAA does not intend to use the EROS Data Center as part of its operational system. We understand that the EROS Data Center will remain as a part of the Department of the Interior and will remain as a part of the Department

of the Interior and will continue to support the Department of the Interior's programs requiring remote sensing data.

Question. What effect does the presence of many foreign Landsat ground stations have on your thinking?

Answer. We are confident that appropriate arrangements between a U.S. privately owned and operated remote sensing system and foreign ground station operators can be achieved which would provide continued direct readout. These arrangements would, by contractual licensing and royalty arrangements between the system owner-operator and the ground station operator, provide for the production, copying, and distribution of remote sensing data on mutually satisfactory terms and conditions.

Question. How should the Government assure the private sector that it will not compete in areas where private sector initiatives and land remote sensing take place?

Answer. A contract between the Government and the private sector owner-operator for a multi-year procurement of remote sensing data would be the best assurance that the Government would not compete with the private owner-operator.

Question. Are there any exclusive rights required to enable practical participation by private sector entity with an operational land remote sensing system?

Answer. No exclusive franchise or monopoly rights need be created to enable practical participation by a private sector entity in an operational land remote sensing system. A commitment from the Government to purchase data will be sufficient incentive for the private sector to invest in the system.

Question. Is legislation needed to encourage private sector participation in an operational remote sensing system?

Answer. The only legislation we foresee as necessary is authorizing legislation which grants NOAA multi-year contracting authority to procure remote sensing data and which excludes such data from the provisions of the Freedom of Information Act (FOIA).

Under the present U.S. copyright laws as presently interpreted, it would appear that data produced by a privately owned and operated system could be protected from unauthorized copying and distribution by private users. Therefore, we believe it is not necessary to enact special copyright legislation to ensure private sector participation.

However, some measure may be required to prohibit the Government from copying and distributing remotely sensed data procured under contract without authorization of the copyright holder. While reasonable arguments can be made that the Government cannot presently copy and distribute copyrighted material without the permission of the copyright holder, recent FOIA court decisions have introduced uncertainty in such a conclusion. Therefore, it would be desirable in any legislative authorization for the procurement of remotely sensed data to provide for the specific exclusion of remotely sensed data from the provisions of the FOIA.

Question. What do you see as the nature of Government's financial support required in this area in the various stages of evaluation of an operational land remote sensing system?

Answer. The Government's financial support for a remote sensing system should be in the form of a multi-year contract for the procurement of remote sensing data. We believe that the adoption of such a process would enable the Government to procure all the data it requires at a cost substantially less than the cost of obtaining the data by a Government owned and operated system.

Question. What involvements should the private sector have in the transition from the present experimental Landsat system to a fully operational land remote sensing system? Does the question of private sector participation in an operational land remote sensing system need to be studied further? If so, who should sponsor and who should conduct such studies? What mechanisms should be set up to provide for industry inputs into the Government now and during the period of transition? What kinds of financial incentives should the Government provide to promote private sector involvement and how do you feel that you could depend on Government commitment?

Answer. We believe that a privately owned and operated system can be achieved by 1985 or 1986. A cooperative arrangement between the Government and the private sector owner-operator would be appropriate during the transitional period (1981-1984) subsequent to the award of a contract and prior to the initiation of service by a privately owned and operated system. Such an arrangement would: (1) relieve NOAA of the need to hire new civil service management and operations personnel who would not, in any event, be needed by the Government after 1985-1986; (2) relieve NOAA of the need to procure additional ground processing equipment which may be incompatible or redundant to the privately owned and operated system or which may not be capable of being transferred to or purchased by the

private sector owner-operator; (3) would involve the owner-operator in pricing decisions that will affect the operational system and eliminate the need for consulting contracts or price studies; and (4) would involve the owner-operator in marketing at an early stage, eliminating the need for NOAA to initiate a marketing effort, resulting in a private marketing and sales force being in place with the initiation of a commercial system in 1985–1986.

We believe that there is no further need to study the question of private sector participation. Several companies have indicated an interest in owning and operating a commercial land remote sensing system. Further study would only serve to delay the transition of the remote sensing activities from the Government to the private sector.

If the Government moves quickly to affect a transition from the Government to the private sector of remote sensing activities, we see no need to create any additional mechanisms for providing industry input into the Government during the period of transition.

A multi-year contract with NOAA for the procurement of remote sensing data would be the best financial incentive the Government could provide. We believe that such a Government contract would constitute an adequate commitment to enable industry to invest in a remote sensing system.

Senator STEVENSON. Thank you. That's very helpful, Mr. Johnson.

Mr. Besserer.

Mr. BESSERER. Thank you, Mr. Chairman. I, too, shall compress my comments and touch briefly, since you have my statement.

We have been involved in the design and application of systems that have been used for the exploitation of such things as Landsat for a number of years, and hence have considerable background in that arena. We're familiar with the past legislation concerning earth resources information and the directive, and so we have decided to address ourselves to a secondary issue in the plan itself. It has many issues, the breadth of them suggesting that we try not to comply with reviewing each of them.

We believe in the value of remote sensing for Earth resources and space. We like the national policy which assures continuity of this effort, which we believe to be absolutely essential. We believe that the risks taken by the private sector will enhance the rate at which new markets are generated and technological innovations introduced.

Today, the data indicate that the Landsat program cannot stand alone as a private venture, and we believe that continued Government financial support will be required for at least the rest of this decade. We believe that it is not in the public interest to just turn a public program over to a private entity which is then subsidized by the Government in any of several proposed ways. In this case, either there is little risk taking or the risk involves not only the private entities' capital investment, but also the continuity of the program.

We believe these views are generally reflected in the transition plan. We find the plan appropriately deals with near-term actions needed to give users the greatest assurance of continued supply of data and to give assurance of its dissemination. Placing the responsibility for the operation of Earth resources in one agency, NOAA, will do much toward eliminating delays in data dissemination and in improving responsiveness to the user community.

Furthermore, relieving NASA of part of its dual responsibility for managing the Landsat system and assuring a continuous stream of product, as well as conducting research and development, will allow both aspects to proceed more efficiently.

We concur with the plan's recommendation to enlist the needs of the data users before initiating new sensor development or new space platforms.

Also of importance is a continuation of programs for training users in ways and means to get the most results out of the system products.

On the other hand, while we note and approve the transition plan's recommended delay in transferring from Government to private control, we are concerned that the delay may not get us any closer to facing the real issues involved in such a transfer.

We believe the transition plan is not sufficiently complete in recommending near term ways of involving the private sector at this stage without relinquishing government control needed to assure the program's continuity.

It has always been possible for a private organization to procure available Landsat products, add value through enhancements, information extraction, interpretation, and sell the results.

We, of course, and other companies have done that. Some of the factors that seem to dampen the profitmaking prospects, however, include the unreliability in terms of availability and timeliness of the needed data, uncertainty about the value contained until the cost of processing it has been already spent, and the unavailability of the Government as a market for derived products.

Specifically, we believe that the Government should retain control of the space segment for the forseeable future; the platform which contains the scanners.

As a stimulus to greater private sector involvement, the Government should change its policy and make the data available at a nominal cost to the private sector immediately upon collection and after preprocessing—that is, sell the raw data stream.

In conjunction with this, the Government should adopt a pricing policy of processed products which reflect the true cost, excluding, at least initially, the space segment. These costs should become chargeable to Government agencies as well as others.

In this way, if the private sector develops better or less costly data processing techniques, the Government market, as well as that of other users, would be available for penetration.

As the market develops and revenues justify larger investment, industry could offset the Government's investment in the space segment by paying a larger price for the data stream.

Downstream, the plan could include orbiting privately owned sensors aboard a Goverment space platform for a nominal fee, just as we are now operating the Shuttle program.

By encouraging creative thought about these and alternate approaches to risk taking by the private sector, I believe we would find a natural phaseover from Government to private operation for the civil remote sensing program as rapidly as profitability is demonstrated.

I iterate our belief in the inherent value to the nation of data from remote sensing from space and our intention to continue seeking opportunities to apply our corporate resources to the development and growth of the Nation's remote sensing capabilities.

I thank you.

That concludes the short statement.

[The statement follows:]

STATEMENT OF C. WILLIAM BESSERER, VICE PRESIDENT AND GENERAL MANAGER, SYSTEMS ENGINEERING AND INTEGRATION DIVISION, TRW DEFENSE AND SPACE SYSTEMS GROUP

Senator Stevenson and members of the Subcommittee on Science, Technology and Space, it is indeed a pleasure to share with you my views on the National Oceanic and Atomospheric Administration's "Transition Plan—for Civil Operational Land Remote Sensing from Space."

My name is William Besserer. I am Vice President and General Manager of the Systems Engineering and Integration Division of TRW's Defense and Space Systems Group. The Defense and Space Systems Group also has divisions involved in Space Systems, Electronic Systems, Ballistic Missiles, Applied Technology and Manufacturing. The Systems Engineering and Integration Division develops and produces systems involving information handling and computer technology both as a prime contractor and as a subcontractor for several agencies of the United States Government, for foreign Governments and for the private sector. TRW's Space Systems Division has been involved in numerous studies involving the design and use of space platforms for earth resources missions. Our work in the area of image processing has influenced and been used in the Landsat earth observation program since its inception.

Recently we have delivered to the Earth Resources Observation System Data Center at Sioux Falls, South Dakota, the currently used EROS Digital Image Processing System (EDIPS) which converts already corrected image data supplied by NASA on high density digital tapes to user oriented products which include film prints and computer compatible tapes. Within the next six months we will deliver an extension to the basic system which will permit the inputting of uncorrected, as well as corrected data to the system, thus further easing NASA's workload, and allowing a shorter response time to the users who want special products.

Another area which reflects the company's interest and capability in the Landsat program is the Japanese Landsat receiving and processing system, which went into operation 18 months ago. TRW was responsible for engineering this system and for delivering certain equipment and software during its construction.

Today, TRW is contributing to the next generation system for resource observation from space, Landsat D. Our role includes the communication of data from the spacecraft through TDRSS (which TRW is developing under contract to Western Union) to its reception on Earth and part of the processing of that data after delivery to NASA. Through these activities we have become well qualified to speak with authority about policies and plans which affect the future of civil remote sensing from space.

TRW is familiar with past legislation concerning earth resources information systems and the Presidential directive naming the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) to manage all operational civilian remote sensing activities from space. We have assisted NOAA through panel discussions in the development of the transition plan about which TRW is being asked for comment.

Now, turning to the transition plan itself, we at TRW are impressed with the breadth of issues covered by the task force in complying with the Presidential Directive of November 1979. Its very breadth, however, precludes a comprehensive discussion so I will confine my comments to possible improvements in the operational program and the ulitmate involvement of the private sector.

We at TRW have long believed in the humanistic value of civil remote sensing of the Earth's resources from space [1] so we openly welcome the national policy which ensures continuity of this effort.

Further, we believe that increased risk taking by the private sector will enhance the rate at which new markets are generated and technological innovation is introduced. Today, unfortunately, data gathered from many sources indicate that the Landsat program cannot stand alone as a private venture and therefore contin-

[1] Statement by Dr. George E. Solomon, Vice President and General Manager, TRW Defense and Space Systems Group, before the Congress of the United States Senate Subcommitee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation, June 13, 1977.

Statement by Mr. Robert L. Walquist, Vice President and General Manager, Space Systems Division, TRW Defense and Space Systems Group, before the U.S. House of Representatives Joint Hearings on Operational Civil Remote Sensing System by the Subcommittee on Space Science and Applications and the Subcommittee on Natural Resources and Environment, June 24, 1980.

ued Government financial support will be required for at least the rest of this decade. TRW believes it would not be in the public interest to just turn the program over to a private entity which is then subsidized by the Government in any of the several proposed ways. In this case, either there is little risk taking or the risk involves not only the private entities' capital investment but also the continuity of the program. These views are generally reflected in the proposed transition plan.

We find that the transition plan appropriately deals with near-term actions needed to give users the greatest assurance of a continuous supply of data and to improve its dissemination. Placing the responsibility for the operational earth resources system in one agency will do much toward eliminating delays in data dissemination and in improving responsiveness to the user community. Furthermore, relieving NASA of one-half of its dual responsibility for managing the Landsat system and assuring a continuous stream of products as well as conducting research and development for future missions will allow both aspects to proceed more efficiently. We concur with the plan's recommendation to listen more closely to the needs of data users before initiating new sensor development, new space platforms and/or new coverage patterns. Also of importance is a continuation of programs for training users in ways and means to get the most results out of system products.

On the other hand, while we note and approve of the transition plan's recommended delay in transferring from Government to private control, we are concerned that the delay may not get us any closer to facing the real issues involved in such a transfer. We believe the transition plan is not sufficiently complete in recommending near term ways of involving private-sector risk taking without relinquishing the Government control needed to assure the program's continuity.

It has always been possible for a private organization to procure available Landsat products; add value through enhancements, information extraction and interpretations and then to sell the results. In fact, this has been done with varying degrees of success by several organizations, including TRW. Factors that seem to have dampened the profitmaking prospects of this kind of activity include: unreliability in the availability and timeliness of needed data, uncertainty about the value contained in an image until the cost of the necessary processing has already been spent, unavailability of the Government as a market for derived products, and fear of Government competition in any long term venture. These factors can be dealt with if supported by Government policy without risking failure of the entire earth observation program.

Specifically, we believe that the Government should retain control of the space segment for the foreseeable future. As a stimulus to greater private sector involvement in the program, the Government should change its policy and make data available at a nominal cost to the private sector immediately upon collection, rather than only after substantial preprocessing. In conjunction with this, the Government should adopt a pricing policy for processed products which reflects true costs (excluding, at least initially, the space segment) and that these costs become chargeable to Government agencies as well as others. In this way, if the private sector developed better or less costly data processing techniques, the Government market as well as that of other users would be available for penetration. Here, NOAA would continue to operate its already-paid-for ground data processing facilities at a reduced output until the private segment demonstrated a profitability that assured the continuity of the program and its stream of data.

As the market develops, and revenues justify larger investment, industry could offset the Government's investment in the space segment by paying a larger price for the data stream. If desired, this mechanism could be introduced at the outset through a competitive bid offering of the data stream at whatever price it was worth according to the marketplace—and the bidding reopened from time to time to assure maximum recovery of the Government's investment.

Downstream, the plan could include orbiting private owned sensors aboard a Government space platform for a nominal fee. Any organization doing so would be entitled to certain rights in the data generated. This concept is similar in many ways to using the Government-owned shuttle to carry private space vehicles into orbit.

By encouraging creative thought about these and alternate approaches to risk taking by the private sector, I believe we would find a natural phase-over from Government to private operation of the civil earth observation program as rapidly as prifitability was demonstrated. Through such approaches there would be no need for subsidies from the Government to assure the program's continuity. Governmental users, just like private users, would pay the private sector for data only after it was demonstrated to be more profitable to do so.

We must remember that just creating a separate organization outside the Government to replace NOAA as operator of the civil earth resource observation program will not guarantee improvement in performance or reduction in cost to the Government. Rather, performance and efficiency are best encouraged in a free marketplace where not only are profits potentially available but the risk of failure is not eliminated through Government subsidies justified by national need.

In any event, TRW's principal corporate interest will continue to be in the development and integration of the space segment and in ground systems and techniques for the collection and processing of earth observation data whether operated by the Government or the private sector. I iterate TRW's belief in the inherent value to the nation of remote sensing from space and our intention to continue seeking opportunities to apply our corporate resources to the development and growth of the nation's remote sensing capabilities.

This concludes my formal remarks. Thank you for the opportunity to participate in this panel.

[The following information was subsequently received for the record:]

QUESTIONS OF THE COMMITTEE AND THE ANSWERS THERETO

PREFACE

In order to clarify the answers to the questions, it is important to note that these answers are based on TRW's recommended approach for the transfer of the land remote sensing business to the private sector. Because TRW's approach is somewhat different than most a brief outline of that approach is presented below.

In essence, TRW's position is that direct Government subsidies to the private sector are to be avoided and that instead legislation and Government policy should make it attractive for industry to become involved and fully responsible for whatever portion of the program it undertakes without monetary subsidies or guarantees of a specific volume of Government business.

Initially, this would be a hybrid approach whereby the Government continues to own and operate te space segment, and the private sector is encouraged to take on the value-added data business. We believe that Government actions which will provide this attractiveness include guaranteeing a continuing supply of data and making the data stream from the satellite available on a nondiscriminatory basis immediately upon receipt at the ground.

In conjunction with this, the Government should adopt a pricing policy for processed products which reflects true costs of processing (excluding, at least initially, the space segment), and that these costs become chargeable to Government agencies as well as others. The private sector should then be encouraged to compete with the Government in the value added business. In this way, if the private sector developed better, more timely or less costly data processing techniques, the Government market as well as that consisting of other users would be available for penetration. Here, NOAA would continue to operate its already-paid-for ground data processing facilities at a reduced output until the private segment demonstrated a profitablility that assured the continuity of the program and its stream of data.

In the present system private organizations can acquire data from the government, add value and use the resulting product for their own purposes or sell it to others. Unfortunately, the data needed as input to the system is only available weeks or months after their collection, while some Government agencies receive them with much shorter delays. Further, a Government using agency rarely bears any portion of the cost of its data and therefore is not likely to ever find it more attractive to obtain products from a private concern who would have to charge a profit-making price for the products. Last, there has been a reluctance by all users to invest in processing systems when the source of input data may cease at any time.

We believe our proposed approach will be financially viable and will provide an efficient transition of land remote sensing products to the private sector at a reasonable level of investment and in a fully competitive environment without risking discontinuity of service.

Question. There has been expressed a concern that private sector operated remote sensing systems might not be responsive to the needs of State and local governments and possibly other small users of such data, or that their requirements would be ignored in favor of large industrial firms or other customers with a greater "ability to pay." How do you envision these concerns would be addressed by the private sector?

Answer. This question is quite pertinent considering the likelihood that prices for products will rise as the programs moves toward a self-sustaining system. Today, State and local governments are able to buy products at reduced cost because the Government is bearing much of the overhead costs of producing these products. Prices will rise as the private sector bears an increasing portion of that overhead. This may cause some hardship to State and local governments, universities or possibly other small users of such data. In order to encourage private sector participation and enhance the overall value of the data (by encouraging developments and innovation from the private sector), TRW recommends that the Government not lower its price when selling data to State or local government or research institutions such as universities. Rather, the Government might choose to make direct subsidies or grants to deserving institutions in order to allow them to purchase data at the established market price.

Question. How can other nations be prevented from using the data from U.S. system to make inroads into the market by offering more attractive terms for the data?

Answer. We don't believe that other nations should be prevented from competing in the open market for the value-added business. What is necessary is to assure that the competition is fair.

Today, other nations have two sources of data: They can acquire it from the EROS Data Center just as others are required to do or they can receive data directly upon transmission from the satellite by constructing their own receiving station and the negotiation of a Memo of Understanding with our State Department. We recommend that this policy be continued with the following changes: Future Memos of Understanding should continue to provide for a fixed yearly charge to cover a portion of the cost of the space segment and they should add a per-scene fee for images received directly, just as users taping the data stream in the U.S. would be charged a per-scene fee.

In reality, the threat of competition by foreign governments is minimum because data that can be received directly from the satellite is limited to a circle of about 1,500 miles radius about the receiving station. Figure 1 shows the locations and regions of coverage for the existing and proposed Landsat stations. From this figure it can be seen that the Canadian stations are the only ones beside the U.S. ones that can directly receive U.S. scenes.

An additional thought concerning this approach is that in negotiating or renegotiating Memos of Understanding, reciprocity clauses should be sought so that should the subject nation (specifically, France and Japan) develop its own space segment, data therefrom would be available to us on the same terms.

Question. How should the Government provide for the civil land remote sensing system to be integrated into military operations during national emergencies if the civil system is in the private sector?

Answer. During national emergencies the Government has always been able to create the power needed to deal with such situations. This would include the civil land remote sensing business. It should be noted, however, that the hybrid approach proposed by TRW allows the Government to maintain control over the space segment and the data stream, and to integrate the system into military operations during national emergencies as required, with a minimum impact on the private sector.

Question. Do you see any problem in transferring to private sector management of the operational system Government technology—that is remote sensing technology developed under Government auspices?

Answer. No; it has always been the Government's policy to disseminate Government developed technology as broadly as possible. Problems in transferring to private sector management are easily perceived and solved if the transition to the private sector proceeds slowly, in small steps, as described in the preface.

Question. Are joint ventures between Government and industry a practical approach to operating a land remote sensing system? What areas or roles should be considered for industry?

Answer. We do not believe that a joint venture in the usual sense (joint management between Government and industry) is a practical approach to operating a land remote sensing system, at this time. The projected revenues do not come close to justifying the investments contemplated, especially the cost of the space segment. This data product market lacks definition, products and services are still developmental, and the market demand versus price has not been established. We believe it is possible to enhance private sector participation in the processing and marketing of data products, by the hybrid approach discussed in the preface.

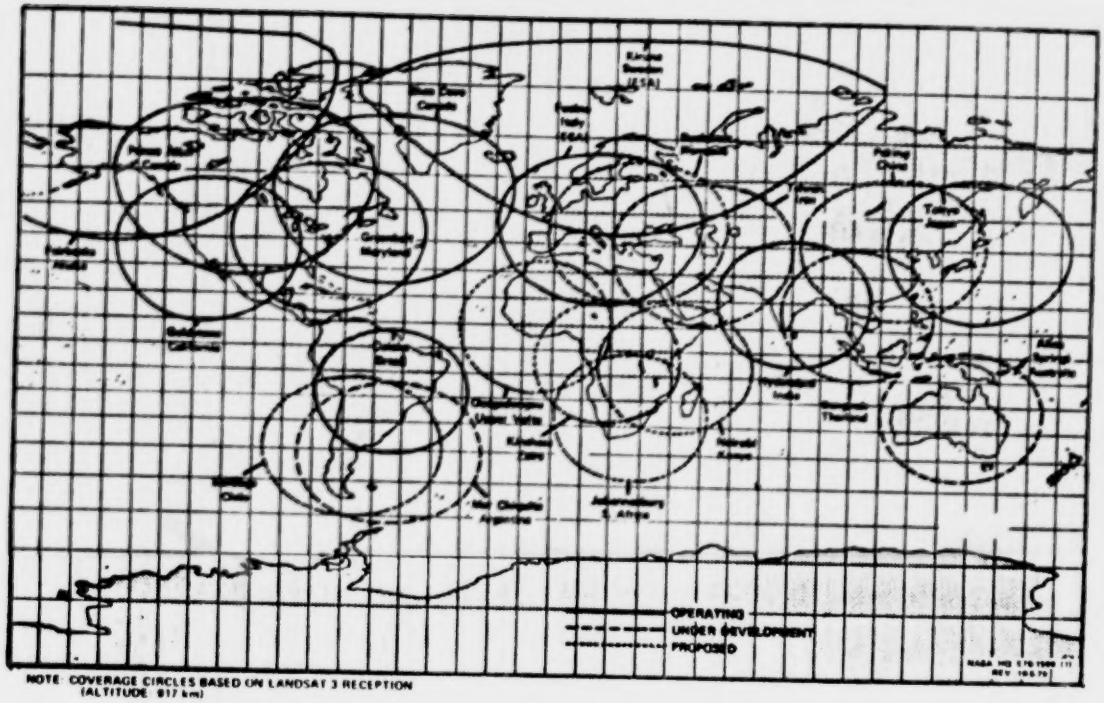


Figure 1. Current and Probable Landsat Ground Stations

QUESTIONS OF SENATOR HEFLIN AND THE ANSWERS THERETO

Question. Is there a substantial commercial market for land-remote sensing data and interpretive services?

Answer. TRW has never performed a survey of the commercial market, and we have had to rely on market analyses performed by other agencies. The results of such surveys show that in general the commercial market is small, with the major fraction of the sales going to the federal government. As the Landsat data technology is improved, and the data become more useful to the user community, it is likely that the commercial market will expand, and become large enough to repay the government its investment in the ground segment.

A market analysis prepared and published by a government interagency task force on June 15, 1979 [1] reported a survey conducted of all Landsat data distributed in 1978. The total Landsat data market consisted of the sale of 273,508 frames at an estimated dollar market volume of $4.8M. The breakdown by user segment is as follows:

Sector	Dollar volume of market	Percent of market
Federal Government	$2,550,876	52
Private industry	579,950	12
Foreign	1,340,539	27
Other—e.g., Universities and State and local governments	374,770	9
Total	4,846,105	100

The 1978 Services Market has been estimated at $20–$28M, and the data analysis equipment market was approximately $12–$16M. This market is made up of 70–80 organizations in the private sector that add value to the Landsat data stream and either sell the resulting product at a profit, or perform research and studies aimed at development, verification or demonstration of the utility of the value-added product. The breakdown of this market segment is as follows:

Market Activity Description	*Annual dollar market (millions)*
Data Analysis Services—manual and computer implemented analysis, interpretation and conversion of Landsat data into information products (statistical, graphical and textual) to be used for operational decision-making	$14 to $18
Special Purpose, Enhanced Imagery Products—Implementation of any of a number of optical and digital enhancement techniques designed to produce a superior Landsat image for visual interpretation.	4 to 6
Data Analysis Equipment—Optically or computer oriented equipment designed for the processing, analysis and interpretation of Landsat data into information useful for decision-making	12 to 16
Computer Data Analysis Packages—Computer programs designated for the processing, analysis and classification of Landsat data for a particular purpose of thematic extraction	2 to 4
Total market	32 to 44

Question Have adequate analyses of present and future commercial and government markets been made?

Answer. The present Landsat data market has been analyzed. See, for example, Landsat users Notes Issue No. 12, May 1980, Pages 4 and 5, (published by U.S. Dept. of Interior Geological Survey, EROS Data Center) for fiscal year 1980 Landsat Stat Statistics, and Historical Landsat Statistics (fiscal year 1973, fiscal year 1979).

[1] Private sector involvement in civil space remote sensing, June 15, 1979, prepared by an interagency task force, NASA, Department of Commerce NOAA, Department of Interior, Department of Agriculture, Department of Defense, E.P.A., U.S. Army Corps of Engineers and Department of State.

The future Landsat data market has also been analyzed. However, the data has been characterized by large uncertainties. Most Landsat applications are currently in the research, demonstration and verification phase. The value-added market lacks difinition, and the associated products and services are undergoing rapid advances. It is unlikely that a repetition of the future market analysis will yield greater accuracies. Rather, the government should proceed with the hybrid approach (discussed in the preface) and study the market as it develops.

Question. Should the government define the performance and physical characteristics of an operational land remote sensing system or should industry?

Answer. As long as it continues to operate and subsidize the space and ground segments, the government should continue to define the performance and physical characteristics of the system.

The methodology for defining physical charcteristics of space systems has been developed over the past two decades by NASA, working closely with private industry. It is suggested that the same proven procedures be utilized to define physical characteristics of an operational land remote sensing system.

The performance and physical characteristics of the ground processing segment, whether owned by the government or the private sector, should be freely determined by the owners.

Question. What considerations of foreign competition are involved in the question of private sector participation in an operational remote sensing system?

Answer. We don't believe that other nations should be prevented from competing in the open market for the value-added business. What is necessary is to ensure that the competition is fair.

Today other nations have two sources of data: they can acquire it from the EROS Data Center just as others are required to do or they can receive data directly upon tranmission from the satellite by constructing their own receiving station and the negotiation of a Memo of Understanding with our State Department. We recommend that this policy be continued with the following changes: future Memos of Understanding should continue to provide for a fixed yearly charge to cover a portion of the cost of the space segment and they should add a per-scene fee for images received directly, just as users taping the data stream in the U.S. would be charged a per-scene fee.

In reality, the threat of competition by foreign governments is minimal because data that can be received directly from the satellites is limited to a circle of about 1,500 miles radius from the receiving station. Figure 1 shows the locations and regions of coverage for the existing and proposed Landsat stations. From this figure it can be seen that the Canadian stations are the only ones besides the U.S. ones that can directly receive U.S. scenes.

An additional thought concerning this approach is that in negotiating or renegotiating Memos of Understanding, reciprocity clauses should be sought so that should the subject nation (specifically, France and Japan) develop its own space segment, data therefrom would be available to us on the same terms.

Question. What effect would existing government facilities such as the EROS Data Center have on private sector ownership of the operational system, and should the government divest itself of such facilties?

Answer. The hybrid approach discussed in the preface would allow foreign ground stations, as well as NOAA and USGS, to continue to operate their already-paid-for ground data processing facilities for government R&D and overall system improvements while the private segment undertakes that portion of the value-added activities that will demonstrate the profitability and utility of the program. As a matter of policy, or perhaps through legislation, the government, as well as foreign ground stations, should not compete with the private sector in the long term venture.

Question. What effect does the presence of the many foreign Landsat ground stations have on your thinking?

Answer. Consideration of foreign competition is discussed in the answer to Question 2. In addition, it is worthwhile to note that the future value of the market will be determined by extensive research, development, verification, and demonstration studies of the utility of the data. Furthermore, in approximately ten years a new generation of spacecraft and sensor technology will be generating a data stream that conforms more closely to user requirements. It would be advantageous not to discriminate against foreign governments initially, for the next ten years. Nondiscrimination increases the size of the user market; it increases the amount of research and development and the probability of a breakthrough that enhances the value of the data stream; it enhances competition; it increases good will; and it leads to greater profit for all participants. At the end of the ten-year period, or when a new space operational system is placed in orbit, this policy may be reviewed and revised if necessary.

Question. How should the government assure the private sector that it will not compete in areas where private sector initiatives in land remote sensing takes place?

Answer. Assurances of fair competition between the government and the private sector should be incorporated into the NOAA enabling legislation. NOAA should establish policies for the sale of the unprocessed data stream. NOAA should be obligated in the enabling legislation to assure that the government charges all users (including the government users) the true cost of all value-added activities. Furthermore, the government should be discouraged from expanding its role in the value-added business in competition with the private sector.

Government users, just like private users, should have the freedom to purchase the most cost effective data products and would purchase data from the private sector only after it was demonstrated to be more profitable to do so. In this way, if the private sector developed better or less costly data processing techniques, the government market, as well as that consisting of other users, would be available for penetration.

Question. Are there any exclusive rights required to enable practical participation by a private sector entity in an operational land remote sensing system?

Answer. It would be advantageous not to grant any exclusive rights to users of the data stream. Nondiscrimination increases the size of the market, increases the amount of research and development and the probability of a breakthrough that enhances the value of the data stream, increases good will, and leads to greater profitability for all participants.

The government must assure that the Freedom of Information Act does not apply to value-added data products. It may be necessary to provide such exemptions through the enabling legislation and provide protection against unauthorized reproduction and distribution of data products by copyright or other legal restraint.

Question. Is legislation needed to encourage private sector participation in an operational remote sensing system?

Answer. The three most important elements that would encourage private sector participation are: a) government assurances of the continuity and availability of data stream so that a private firm could amortize its investment over a long term without risk of stream termination, b) assurance that government owned and operated ground processing facilities will not be given a cost advantage in competing with the private sector; that is, the government should be obligated to charge all users (including government users) the true cost of all value-added products, and c) the government should make the raw data available to the private sector as soon as it is collected so that the private sector can include timeliness as a feature in selling its value-added products.

It is recommended that NOAA's enabling legislation include policy statements and assurances that encourage private sector participation in the value-added business.

Question. What do you see as the nature of the government's financial support required in this area in the various stages of evaluation of an operational land remote sensing system?

Answer. As discussed in the preface, we recommend that the government continue to own, operate, and pay for the space segment of the land remote sensing system. We do not recommend financial incentives or subsidies for the value-added ground segment of the system. Rather, performance and efficiency are best encouraged in a free marketplace where not only are profits potentially available but the risk of failure is not eliminated through government subsidies justified by national need.

Question. What involvement should the private sector have in the transition from the present experimental Landsat system to a fully-operational land remote sensing system?

Answer. The answer to this question is discussed in the preface to this set of questions and answers.

Question. Does the question of private sector participation in an operational land remote sensing system need to be studied further? If so, who should sponsor and who should conduct such studies?

Answer. We do not believe that the question of private sector participation needs to be studied further at this time. We recommend that the hybrid approach discussed in the preface be implemented as soon as possible. The private sector will then be encouraged to develop better or less costly data processing techniques and enhance the value and profitability derived from the data stream. As the market develops and revenues justify larger investment, the question of private sector participation may be reopened and a study warranted.

Question. What mechanisms should be set up to provide for industry inputs to the government now and during the period of transition?

Answer. We support the Commerce Department plans in fiscal year 1981 to establish a land remote sensing Satellite Advisory Committee. In addition, the requirements and recommendations of ad hoc private sector committees, such as the Geosat Committee, Inc., should be factored into the government's planning process.

Additional mechanisms need not be set up to provide for industry inputs to the government, now or during the period of transition. Rather, performance and efficiency are best encouraged in a free marketplace where not only are profits potentially available, but the risk of failure is not eliminated through government subsidies justified by national need.

Question. What kind of financial incentives should the government provide to promote sector involvement and do you feel that you could depend on government commitments?

Answer. We do not recommend financial incentives and subsidies from the government to promote sector involvement as discussed in our answer above.

Remote resource sensing has depended on government commitments in the form of funding, policy statements and enabling legislation for the past two decades. We feel that we can depend on government's commitments at least for the first phase (ten-year period) of the program.

Senator STEVENSON. Thank you, sir.

Mr. Batchelder.

Mr. BATCHELDER. Thank you, Mr. Chairman.

I'm grateful for this opportunity to appear before you today.

By way of background, our company, Itek, built the multispectral camera for Skylab. We recently completed the large format camera for the Space Shuttle, and along the way we built the panoramic high-resolution camera for Apollo and the lander camera for Viking.

Several qualities appear to us to be important to users of remotely sensed data; for example, coverage, timeliness, spectral or radiometric fidelity, and geometric attributes.

Landsat has been directed primarily at applications which require emphasis on the first three of these qualities, that is, coverage, timeliness, and spectral fidelity—that's needed particularly for agricultural forecasting.

Landsat is lacking in the geometric attributes, such as high spatial resolution, stereo, and precision that are needed by some of the largest operational users of Landsat or other remotely sensed imagery for worldwide mapping, charting, and geologic interpretation.

Numerous reports have been published, addressing user requirements for spatial resolution for various applications. And I don't want to quote all of them.

I don't see, however, how we can realistically set operational system requirements, including the geometric as well as radiometric and timeliness requirements until we assess the relationships between demand, quality, and cost of the products. This hasn't been done today.

In the near term, the United States has few options for meeting the needs of some major operational users for better quality space imagery and for maintaining leadership in this branch of space technology.

One option is to make a firm operational commitment to fly advanced photographic sensors on the Space Shuttle. In my text there are some illustrations of some of the hardware that exists to accomplish this task or this function and suggestions of how it might be accomplished.

These cameras are in NASA's inventory, and they could go a long way toward meeting the geometric needs of some major data users.

Flown piggyback as secondary Shuttle payloads, these cameras could efficiently cover much of the world's land area in stereo, with resolution 10 to 20 times better than Landsat and with high object location precision.

In fact, if we looked at the performance of cameras such as the large format camera and the panoramic camera from the Apollo program, which exists down at the Johnson Space Center, these would meet the ultimate requirements of resolution and stereo heighting accuracy contained in NOAA's transition plan.

Photographic systems have a long history in national defense, but have received relatively little consideration for remote sensing, in part because of the costs associated with expending a costly camera, along with an even more costly spacecraft, on a mission limited by the film capacity of the system.

This limitation no longer exists in the era of the Space Shuttle, which can be used like a survey aircraft to carry cameras when and where they're needed and return them to earth for reuse.

The operational cost of such missions should be far less than projected costs for free-flying spacecraft and sensors, depending on Space Shuttle service charges.

NASA is quite properly reluctant, we believe, to undertake a leading role in managing such an operational data collection program. With the designation of NOAA as an operational manager of remote sensing programs, however, we have an opportunity to develop operational procedures and test market demand that could lead to eventual private operation of cameras in space, much as private contractors now provide the bulk of worldwide aerial mapping photography.

I urge that Congress favorably consider funding NOAA for this purpose.

Now, beyond this point, although photographic cameras on the Space Shuttle are low in investment cost and appear to be the only viable way for the United States to obtain imagery from space with high geometric quality in the near term, there's no doubt that new eletro-optical technology will be employed on eventual operational systems for a variety of reasons.

New electronic technology is capable of providing long arrays of light detectors, such as this one that I have here in prototype form, which are electronically scanned without moving parts.

This method has advantages in reliability, geometric precision, and a superior combination of sensitivity and spatial resolution characteristics.

This particular array has a resolution of more than 10,000 elements, which is about 20 times the resolution, the linear resolution, of a normal TV camera and about 5 times the equivalent linear resolution of a Landsat MSS.

We have developed a prototype aerial camera using this technology, and there's a picture in my prepared text that shows a representative image, transmitted and displayed in real time from that system.

We're under contract to the U.S. Geological Survey to explore the use of this technique in a Mapsat system that provides many of the coverage, timeliness, and spectral qualities of the Landsat, together with the geometric attributes required for mapping.

Along with our sponsors, we hope that this concept will be favorably considered by NOAA in establishing requirements for an operational remote sensing system.

Progress, to date, in aerial applications of this technology would suggest that we could fly an operational line array sensor well before the 1990's.

Whether operational sensors in satellites such as those I've described will ultimately be funded by private investment depends on a number of economic issues that are far from solution at this point.

These include the presence of competitive systems subsidized by the United States or foreign governments, copyright protection for the imagery received, costs of launch and support services such as operating time on orbit and stay-lengths, international regulatory restrictions on data acquisition and dissemination, and so forth.

I don't believe these issues will be close to resolution until new generations of operationally oriented systems are funded and flown for evaluation by both the United States and foreign governments and are employed in both the Space Shuttle and free-flying satellites.

We also lack experience to realistically evaluate the market for space imagery since the EROS Data Center sells its products for only the marginal cost of reproduction. This is justifiable as a loss leader, if you will, to introduce a new program such as Landsat.

But if the Government is serious about making the transition to a commercially operated system, it should begin testing the price elasticity of its product, up to the level estimated for eventual total cost recovery.

Aerial-mapping photography sells on the commercial market for about $3 to $5 per square mile of coverage, which equates to a replacement value of $30,000 to $50,000 for a frame covering the area of a Landsat frame if it had excellent geometric quality. This compares with the EROS price of less than $10 per Landsat frame.

Obviously, we are a long way from knowing what the market worth of space imagery is and from knowing whether the market justifies a $30 million to $50 million sensor investment, which would be equivalent to only about 1,000 frames, at the going rate, for aerial coverage.

In summary, these are the points I'd recommend you consider in near-term legislation:

First, to fund NOAA or NASA to conduct interim operations of remote sensors on Space Shuttle flights, emphasizing photography with high geometric quality, as well as new sensing technologies. Many domestic and foreign users are already equipped to use the pictures that would result from these flights, but we need to develop experience in integrating the sensors with the Shuttle cargo manifest and in integrating sensor operations with other mission activities.

Second, I believe we should implement a policy increasing the prices for Government-acquired data to test market demand and price elasticity at various levels of product quality.

Total cost recovery will be required in future commercial remote-sensing systems. In the interim, allocation of direct costs of public benefits to using agencies will determine the size of the real Government market for the product acquired.

Third, I'd suggest that you provide funds to expedite development of a new system, using linear array technology like the USGS Mapsat concept, addressing multiple user operational requirements for coverage, timeliness, spectral fidelity, and geometric quality, including high resolution stereo capabilities.

Finally, I'd suggest that the Congress monitor the development of remote sensing operational requirements to insure that new federally funded systems truly address the broadest possible constituency of both public and private users and the latest available technology.

Maximum flexibility should be retained during the years of system development and evaluation to test multiple alternatives before we commit ourselves to an operational configuration.

Thank you, Mr. Chairman.

And I'm sure you have some questions.

[The statement follows:]

STATEMENT OF ROBERT R. BATCHELDER, VICE PRESIDENT, ITEK OPTICAL SYSTEMS

INTRODUCTION

I am grateful for the opportunity to appear before you today to give my views on the U.S. program for space remote sensing and the uses of remotely sensed data in earth resource surveys. My company, Itek Optical Systems, is proud if its contributions to this program, in particular through the Skylab S-190A multispectral camera and the recently completed Large Format Camera for the Space Shuttle. We also designed and built imaging sensors for the Apollo and Viking programs, and several important reconnaissance systems.

In my remarks today, I would like to touch on four issues that I believe tend to be obscured or ignored in the proposals for systems and institutional arrangements that have been laid before you. First is the question of required data quality. Second is the potential for use of the Space Shuttle to acquire earth data (at least on an interim operational basis) and to demonstrate new sensing techniques. Third is the application of new sensor technology to eventual operational remote-sensing systems. Fourth is the need for better economic yardsticks of the worth of remotely sensed data before industry will assume significant dollar risks to address the market.

DATA QUALITY

There is no doubt that the LANDSAT system has fulfilled a valuable purpose in demonstrating new techniques for image acquisition, processing, and interpretation. In addition, there are operational needs that LANDSAT is unquestionably capable of satisfying. Both the U.S. Geological Survey and the Defense Mapping Agency are users of LANDSAT imagery for small-scale map updates and charting of certain marine areas. It is significant that oil and mineral companies are among the largest purchasers of LANDSAT imagery from the EROS Data Center. LANDSAT is not an experimental system to them. The techniques for regional geologic interpretation are well developed and have proved to be cost effective in guiding more expensive followup methods of exploration to the most promising sites.

The U.S. can take pride in the initiative shown by NASA and other government agencies in sponsoring this program. Yet for all our achievements, we have to ask whether we still have the initiative, and whether the remote sensing program is realizing its potential. Unfortunately, the answer is no. LANDSAT lacks specific qualities that are urgently needed by broad segments of the community data users. The result is that the initiative for new generations of remote sensors is passing to foreign governments—specifically, the French SPOT systems, European LASS, and a remote-sensing satellite planned by the Japanese. We are familiar with these

activities because foreign contractors have been coming to us for technical assistance.

Several qualities are important to users of remotely sensed imagery—for example, coverage, timeliness, spectral or radiometric fidelity, and geometric attributes. LANDSAT has been directed primarily at applications that require emphasis on the first three of these qualities—coverage, timeliness, and spectral fidelity—as needed particularly in agricultural forecasting. LANDSAT is notably lacking in the geometric attributes—high spatial resolution, stereo, and precision—that are sorely needed today by the largest operational users of LANDSAT imagery for world-wide mapping, charting, and geologic interpretation.

Numerous reports have been published addressing user requirements for spatial resolution for various applications. The GEOSAT Committee, for instance, has documented a need for 30-foot (10-meter) resolution for petroleum and mineral exploration. Map makers need to recognize objects as small as 30 feet in size to draw maps at the commonly used scale of 1:50,000. Both disciplines require stereo to see terrain folds, and accurate positioning of features is essential. Fortunately, applications requiring the utmost in geometric quality do not require immediate data return, and conversely users needing rapid access to the data can generally accept degraded geomeric attributes.

Fig. 1, enclosed with my prepared text, gives a summary of resolution requirements for several particular applications, and a composite curve of applications satisfied versus resolution from a well known 1972 OMB report. For the overlayed performance bars, it is clear that LANDSAT—even the Thematic Mapper—is far from meeting the need. However, photographic cameras that have been proven in space could significantly enhance the utility of space imagery.

USE OF THE SPACE SHUTTLE FOR REMOTE SENSING

In the near term, the U.S. has few options for meeting the immediate needs of the major operational users for better space imagery, and for maintaining leadership in this branch of space technology. One option is to make a firm operational commitment to fly advanced photographic sensors on the Space Shuttle. Figs. 2 and 3 in my text describe the installation and applications of cameras that are in NASA's inventory and which would go a long way toward meeting the geometric needs of major data users. Flown "piggyback" as secondary shuttle payloads, these cameras could efficiently cover most of the world's land area in stereo, with resolution 10 to 20 times better than LANDSAT, and with high object-location precision.

Photographic systems have a long history in national defense, but have received little consideration for remote sensing, in part because of the costs associated with expending a costly camera along with an even more costly spacecraft on a mission limited by the film capacity of the system. This limitation no longer exists in the era of the Space Shuttle, which can be used like a survey aircraft to carry cameras when and where they are needed, and return them to Earth for reuse. The operational cost of such missions could be far less than projected costs for free-flying spacecraft and sensors, depending on Space Shuttle service charges.

NASA is quite properly reluctant to undertake a leading role in managing such an operational data collection program. With the designation of NOAA as operational manager of remote-sensoring programs, however, we have an opportunity to develop operational procedures and test market demand that could lead to eventual private operations of cameras in space, much as private companies now provide the bulk of world-wide aerial mapping photography. I urge that Congress favorably consider funding NOAA for this purpose.

NEW SENSOR TECHNOLOGY

Although photographic cameras in the Space Shuttle are low in investment cost, and appear to be the only viable way for the U.S. to obtain imagery from space with high geometric quality before the late 1980's, there is no doubt that new electro-optional (EO) technology will be employed on eventual operational systems. Electro-optics have several advantages over photographic cameras:

EO detectors can cover a broader spectral range in the infrard wavelengths than film emulsions. The practical significance of this range, however, remains to be proven.

A satellite with electronic sensors can be continuously available in orbit, as opposed to a film camera flown sporadically in the Space Shuttle. This results in regular and timely coverage, which is important for agricultural and some other applications. In addition, frequent access to areas that are often cloud-covered increases the probability of obtaining cloud-free imagery.

The wide sensitivity range of EO detectors, properly processed and transmitted, enables the discrimination of low contrast features in a scene to a greater degree than with photography. This is particularly important to the geologic interpreter, who can sometimes infer subsurface structures typical of oil and gas deposits from the subtle surface differences in tone between soil and rock types or areas of stressed and normal vegetation.

Digital data from EO sensors can be accepted directly by automated processors for transformation into formats convenient for specialized interpretation.

The principal LANDSAT sensors—both the Multispectral Scanner and Thematic Mapper—use technology developed in the 1960's. These sensors have small arrays of individual light detectors in each of several spectral bands that are mechanically scanned across the scene by a moving mirror. New electronic technology is capable of providing long arrays of light detectors, such as this one (Fig. 4), which are electronically scanned without moving parts. This method has advantages in reliability, geometric precision, and a superior combination of sensitivity and spatial resolution characteristics. Itek has developed a prototype aerial camera using this technology, and Fig. 5 shows a typical image transmitted and displayed in real time. We are under contract to the U.S. Geological Survey to explore the use of this technique in a MAPSAT system that provides many of the coverage, timeliness, and spectral qualities of LANDSAT together with the geometric attributes required for mapping. Along with our sponsors, we hope this concept will be favorably considered by NOAA in establishing requirements for an operational remote sensing system for deployment in the late 1980's.

COMMERCIALIZATION OF SPACE REMOTE SENSING

Whether operational sensors and satellites such as those I have described will ultimately be funded by private investment depends on a number of economic issues that are far from solution now. These include the presence of competitive systems subsidized by the U.S. or foreign governments, copyright protection for the imagery received, costs of launch and support services such as operating time on orbit and communications links, and international regulatory restrictions on data acquisition and dissemination. I don't believe these issues will be close to resolution until new generations of operationally oriented systems are funded and flown for evaluation by both the U.S. and foreign governments, and are deployed in both the Space Shuttle and free-flying satellites.

We also lack experience to realistically evaluate the market for space imagery, since the EROS Data Center sells its products for only the marginal cost of reproduction. This is justifiable as a loss leader to introduce a new program such as LANDSAT, but if the Government is serious about making the transition to a commercially operated system it should begin testing the price elasticity of its product up to the level estimated for eventual total cost recovery. Aerial mapping photography sells on the commercial market for $3 to $5 per square mile, which equates to a replacement value of $30,000 to $50,000 for a frame covering the area of a LANDSAT frame, but with good geometric quality. This compares with the EROS price of less than $10 per LANDSAT frame. Obviously, we are a long way from knowing what the market worth of space imagery is, and from knowing whether the market justifies a $30 to $50 million sensor investment (equivalent to only 1,000 frames at the going rate for aerial coverage).

Regardless of the eventual ownership of the space segment of a remote-sensing program, there is no question that the private sector will play an increasing role in exploitation of remotely sensed data. There are already a large number of private firms and institutions with groups specializing in the processing and interpretation of LANDSAT imagery. I believe future data utilities will treat space data from all sources as but one element of comprehensive data bases, offered for sale to governmental and commercial customers in a variety of discipline areas such as geology, agriculture, demography, etc. These enterprises are perfectly compatible with current policies for data collection and dissemination.

SUMMARY

In summary, these are the points I would recommend that you consider in near-term legislation:

Fund NOAA and NASA to conduct interim operations of remote sensors on Space Shuttle flights, emphasizing photography with high geometric quality as well as new sensing technologies. Many domestic and foreign users are already equipped to use the pictures that would result from these flights, but we need to develop experience integrating sensors with the Shuttle cargo manifest, and in integrating sensor operations with other mission activities.

Implement a policy increasing the prices for Government-acquired data to test market demand and price elasticity at various levels of product quality. Total cost recovery will be required on future commercial remote-sensing systems. In the interim, allocation of direct public benefits to using agencies will determine the size of the Government market for the products acquired.

Provide funds to expedite development of a new system using linear array technology like the USGS MAPSAT concept, addressing multi-user operational requirements for coverage, timeliness, spectral fidelity, and geometric quality, including high resolution stereo capabilities.

Monitor the development of remote-sensing operational requirements to ensure that new federally funded systems truly address the broadest possible user constituency (both public and private) and latest available technology. Maximum flexibility must be retained during the years of system development and scientific evaluation to test multiple alternatives leading up to an operational decision.

The Administration's goal of commercialization of remote-sensing activities is a laudable one, and the success of NOAA in managing the meteorological sensing program gives promise that this agency will also be an efficient manager of an integrated remote-sensing effort. Indeed, I believe there are real possibilities for economy through common use of satellites, ground facilities, and support staffs for data collection from the earth's atmosphere, oceans, and land areas with specialized sensors. I don't see a need for major new mandated programs, but I do see a need for more effective monitoring and direction of our on-going activities. This may lack the drama of a new departure, but I am convinced it will lead us to more useful results, more quickly and more economically.

Thank you for your attention. I would be glad to answer your questions.

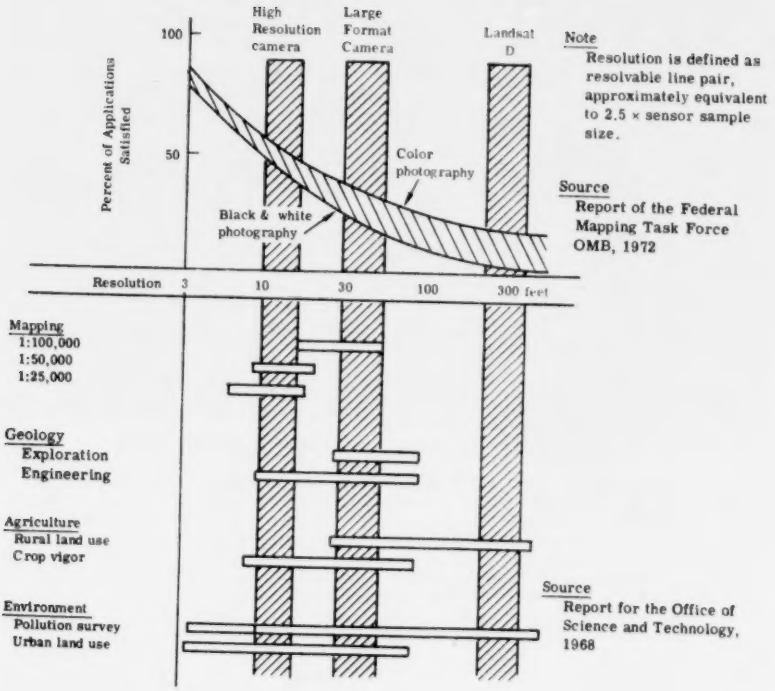
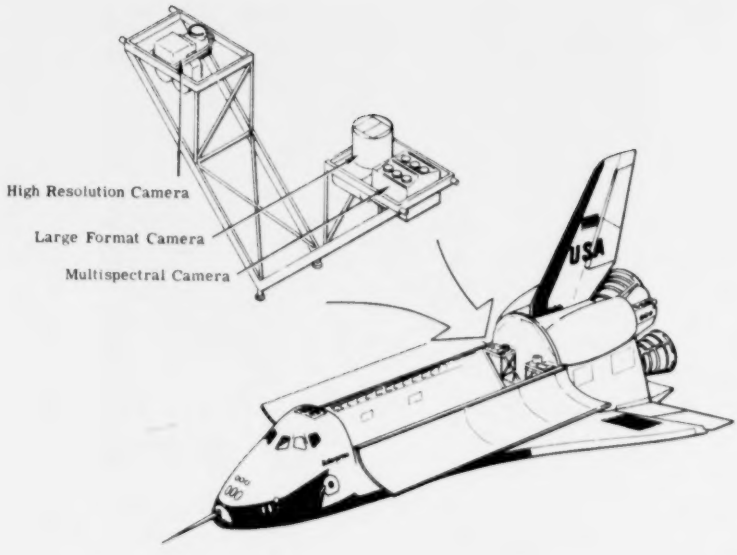


Fig. 1 — Resolution requirements for remote sensing



- Carry cameras on space-available basis on frequent Shuttle flights
- Shuttle orbits cover more than 80 percent of world land mass in 1982, total globe in 1984
- High-value cameras are recovered for reuse

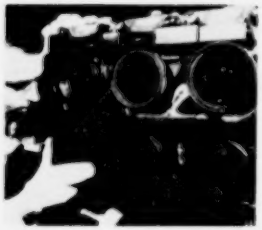
Fig. 2 — The Space Shuttle can be used for economical surveys in space

High Resolution Camera

- 10-foot stereo resolution enables identification of man-made objects
- Available from Apollo program

Large Format Camera

- Undistorted view for economical mapmaking
- Strong stereo for terrain contouring
- Completed for use on Space Shuttle



Multispectral Camera

- Accurate color measurement for land use and terrain classification
- Available from Skylab program

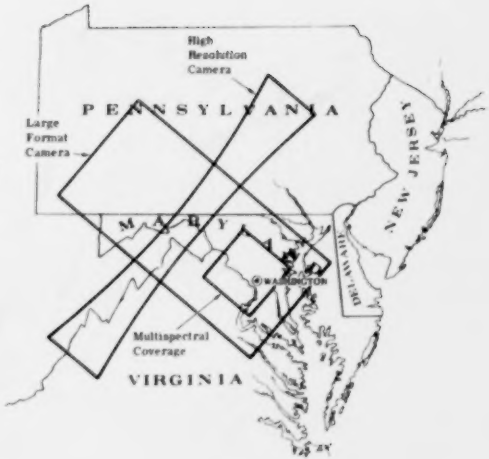


Fig. 3 — A complementary set of cameras is essential to meet a broad range of customer needs

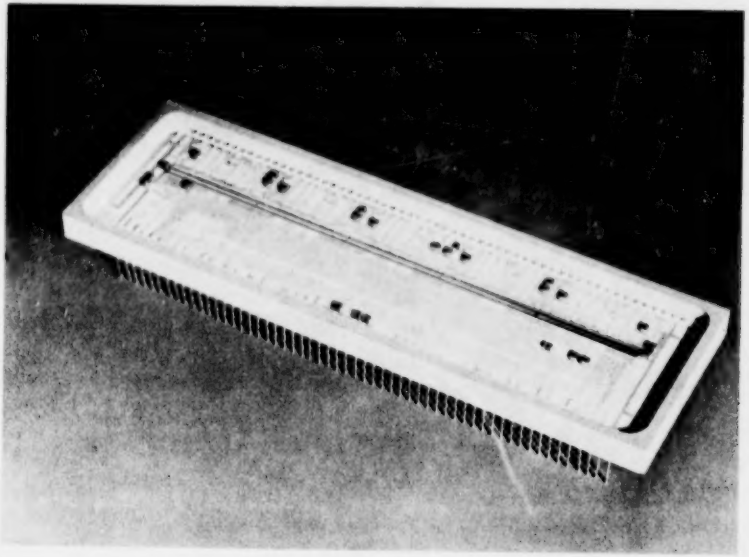


Fig. 4 — Prototype EO line array focal plane

Fig. 5 — Sample image of Los Angeles area from prototype aerial EO line array camera

[The following information was subsequently received for the record:]

QUESTIONS OF THE COMMITTEE AND THE ANSWERS THERETO

Question. There has been expressed a concern that private sector operated remote sensing systems might not be responsive to the needs of state and local governments and possibly other small users of such data, or that their requirements would be ignored in favor of large industrial firms or other customers with a greater "ability to pay".

How do you envision these concerns would be addressed by the private sector?

Answer. It appears that the state and local representatives would define "responsive" as "low cost", as with current Landsat products. No commercial venture can continue to distribute data products at the cost of reproduction, failing to recoup the necessary investment in satellites and ground facilities. In fairness, state and local governments will be asked to pay the same prices as "large industrial firms", for a higher-quality product than is now available from Landsat. If the value of the application is inconsistent with its cost, then perhaps the Federal support could be solicited or the application dropped.

Question. How can other nations be prevented from using the data from the U.S. system to make inroads into the market by offering more attractive terms for the data?

Answer. The basic data products must be protected by international copyright convention to prevent unauthorized reproduction for secondary sale. Data transmitted directly from a satellite sensor to a foreign readout station will bear a charge similar to that for data distribution from the United States. These provisions should inhibit unfair foreign advantage or inequitable cost assessment in data distribution.

Question. How should the government provide for the civil land remote sensing system to be integrated into military operations during national emergencies if the civil system is in the private sector?

Answer. Precedents exist in the Merchant Marine and Civil Reserve Air Fleet for government assumption of control of private assets in return for fair compensation. Such provisions should be included in regulations or contracts enabling private remote sensing operations.

Question. Do you see any problem in transferring to private sector management of the operational system government technology—that is remote sensing technology developed under government auspices?

Answer. No. government property transferred to a commercial venture should bear a fair fee for use. Intangible assets such as technology or designs owned by the government should be made available to all users in the public domain without charge. These policies are consistent with long standing practices in high-technology industries serving both government and private markets.

Question. Are joint ventures between government and industry a practical approach to operating a land remote sensing system? What areas or roles should be considered for industry?

Answer. In the near term, cost sharing ventures between government and industry could expedite development and demonstration of a diversity of remote sensing approaches. A typical arrangement might result in the government operating an available sensor on the Space Shuttle, with an industrial firm responsible for mission programming, primary data processing, and data distribution to users. In an eventual operational venture, government launch services might be traded against the price of data provided to the government.

Question. Do U.S. agencies, foreign governments or industry have user requirements that could be satisfied by use of photography from the Large Format Camera and Apollo Panoramic Camera for remote sensing applications? What is the earliest date such cameras could be deployed on the space shuttle to service these users?

Answer. USGS, several foreign governments, and the GEOSAT Committee composed of industry users are all on record supporting operational flights of the LFC. The Defense Department is also a potential user. The NOAA Transition Plan identifies ultimate requirement of 2-meter resolution and 15-meter stereo heighting accuracy, both of which could be met immediately with these systems. NASA plans currently to provide for a single LFC flight in 1984. The cameras could be ready for use in the earliest shuttle operational flights.

Question. Assuming two or three missions per year with one or two at an inclination of 50 degrees and each with about 10 days duration, what would be the five year cost of operating the Large Format Camera and Apollo Panoramic Camera on the space shuttle? What would the cost be of operating these cameras on a free-flying spacecraft orbited and replenished by the shuttle twice a year?

Answer. The estimated cost for the first flight of a combined shuttle payload including the LFC and two refurbished Applo Panoramic Cameras, with necessary supporting equipment and services, is $15-20M.

Total mission costs including shuttle launch and service charges cannot be stated because of uncertainty in shuttle capacity and the mission fraction allocated to the camera payload. NASA stated in August 1980, before the International Society of Photogrammetry that an operational Photographic flight would bear the full $22M shuttle luanch cost. This does not seem reasonable for a payload weighing less than 2,000 lbs, 4 feet long, and operating for less than 8 hours in a typical 10-day mission. The European Space Agency announced to the same ISP conference its plans to fly a less-capable camera complement on Spacelab, and charge users only a basic price for coverage.

Development of costs for a free-flying photographic satellite needs further study to define replenishment constraints and a refurbishment cycle. Either of these alternatives, however, appear to offer significant cost and time savings over NOAA's estimates in its Transition Plan.

Question. Could the United States launch a multi-spectral linear array stereo sensor before the French or other governments do so? Could such a U.S. system be configured to be superior to the contemplated foreign systems? If so, in what way.

Answer. The French appear to be dependent on U.S. technology in key areas such as the focal plane array for their SPOT satellite. Although the first of these systems is well into development, based on current experience with aerial EO cameras it appears possible for U.S. industry to produce a sensor similar to SPOT in two to three years. Such a sensor could be configured to fly on a Landsat-D type of spacecraft in 1984, if authorized in early fiscal year 1981. The characteristics of SPOT and a MAPSAT concept being developed for USGS are provided in attached papers. The sensors have equivalent resolution and spectral bands, but MAPSAT covers a wider swath, uses current Landsat data channels, and has superior geometric characteristics.

Question. Would early availability of a linear array test bed on the space shuttle assist in the development of advanced sensors and data processing technologies and new applications? How soon could such a system be deployed?

Answer. Several new features are under consideration for advanced remote sensors, including the use of long line-array sensors, adaptive data compressors, and simplified processing of stereo image pairs to derive terrain height data. Based on theoretical and laboratory work accomplished to date, there is no question of feasibility in applying these techniques to an operational system. Subtle features in real scenes, however, require evaluation to optimize final component designs, to determine operational limits, and to acquire experience that builds confidence in the system approach. For an estimated cost of $4-5M, a line-array sensor test bed could be produced in less than two years for shuttle deployment. this unit would permit early evaluation of component prototypes against real low-contrast, low-relief scenes under a varity of lighting and atmospheric conditions.

Attachments.

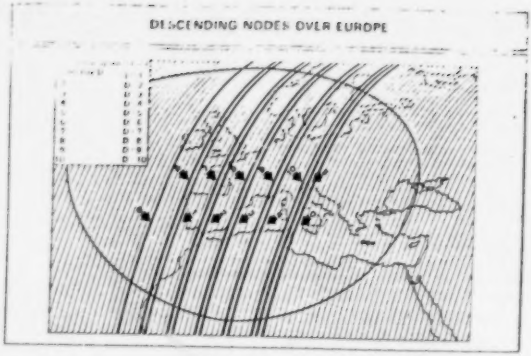


FIGURE 11

3/2 description of the first spot satellite

3.2.1. orbit

The observation of natural resources from space requires a ground resolution of between 10 and 100 m, particularly in Europe where land division is on a small scale. For this application, space observation from geostationary orbits is beyond the capabilities of present-day technology. A low-altitude circular orbit has therefore been selected, in order to obtain the required resolution, despite the disadvantage of intermittent regional coverage. The orbit is in a nearly polar plane, so that the satellite will overfly all regions of the globe.

Furthermore, it is important that successive images be obtained under the same conditions of illumination. This means that the satellite must pass over any given region at the same solar time on each occasion. In the absence of perturbations, the plane of the orbit would remain fixed relative to a sidereal reference, whereas the Earth-Sun direction moves through almost 1° per day (or, to be precise, 360° in 365.24 days). Fortunately, however, the oblateness of the Earth perturbs the motion of a low-altitude satellite and produces precession of the plane of orbit. By selecting an appropriate value for the inclination of the orbit relative to the Equator, a rate of precession of precisely the required value (i.e. almost 1° every 24 hours) can be achieved, thus ensuring that the geometrical relationship between the orbit and the Sun-Earth direction is maintained.

Such orbits are termed sun-synchronous: satellites placed in these orbits always pass over a given latitude at the same solar time. From the celestial mechanics viewpoint, the choice of time is unimportant, though clearly image quality will be greatly affected.

In the case of SPOT, it is also desirable to maximize the number of occasions when stereo pairs of images can be taken at suitable viewing angles and at an interval of one day, thus ensuring that no significant change takes place between the acquisition of one image and its pair. The fact that the instrument pointing angle can be varied over a certain range means that specular reflection of sunlight from bodies of water must be taken into account when selecting the local pass time. This choice is thus made by taking into account the considerations already mentioned and by maximizing the period of the year during which the solar zenith angle (θ_s) is greater than 60°.

Finally, it is also desirable to be able to compare successive images of a given region taken from precisely the same angle of view. This is only possible if the satellite periodically passes over the same point after a whole number of days corresponding to a repeat cycle. This, in turn, assumes a precise relationship between the time required for the satellite to complete one revolution of the planet and the period of rotation of the Earth. This relationship is here termed the «phasing» of the orbit. Suitable phasing is obtained for certain discrete values of the orbit altitude and inclination. The following orbit parameters were selected from these discrete values:

- near-polar circular orbit,
- mean altitude: 822 km,
- inclination: 98.7°,
- period: 101 minutes,
- repeat cycle: 26 days,
- equatorial crossing time: 10.30 (descending node).

For such an orbit and a maximum instrument pointing angle offset of ± 26°, the «accessibility» to a given zone at latitude 45° will be as follows:

- if the zone is on the satellite ground track on day D, then it will also be observable, from varying angles, on the following days: D + 1, D + 5, D + 6, D + 10, D + 11, D + 15, D + 16, D + 20, D + 21, D + 25 and D + 26.

A zone on the equator, will be accessible only on D, D + 5, D + 10, D + 11, D + 15, D + 16, D + 21 and D + 26.

Thus, the possible viewing periods for zones at latitudes about 45° correspond to six stereo pairs at one day intervals every 26 days. The series of intervals separating the recording of pairs of images will be, for a 26-day cycle: 1, 4, 1, 4, 1, 4, 1, 4, 1, 4, 1. Similarly, at the equator, two stereo pairs will be available with a one-day interval.

The combination of an instrument capable of pointing angle offset and a carefully selected swath pattern ensures a high degree of operational flexibility. For instance, zones of special interest can readily be observed with increased frequency or stereo-imaged more regularly than would be possible otherwise.

3.2.2. payload

The first payload will include two identical HRV instruments. Data generated by these instruments will be transmitted to the ground over a specific telemetry link.

3.2.2.1. HRV INSTRUMENT

Fine ground resolution being a basic mission specification, all mechanical scanning systems were excluded from consideration.

The HRV instruments designed for SPOT form images without the use of any moving mechanical part (e.g. scanning mirrors, disk choppers or mechanical modulators). Rather, images are obtained using the «push-broom» scanning mode:

- each line of the image is formed by a linear array of detectors located in the instrument focal plane, the scanning of the line being performed electronically,
- the successive lines of the image are produced as the satellite moves forward along its orbital track *(see figure 12)*.

PUSH-BROOM SCANNING CONCEPT
DIAGRAMMATIC ILLUSTRATION

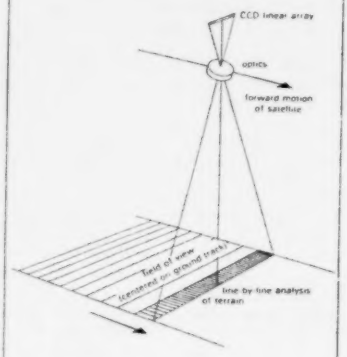


FIGURE 12

The sensitivity of the HRV instrument is such that grey-level reflectance differences of the order of 0.5% can be detected under suitable conditions of illumination (i.e. Sun at more than 30° above the horizon, or $\theta_s \leq 60°$).

A basic requirement of all multispectral systems is the registration of different images of a given scene recorded in different spectral bands. The SPOT specification in this regard is for image registration to within a few tenths of a pixel (or picture element). By using a dichroic prism for spectral separation, effective point-to-point registration is obtained in the raw image. This approach has thus been selected for the color channels. The panchromatic channel is separated from the multispectral channels in the instrument field of view.

OPTICS

Naturally, the optical quality of the HRV instrument is critical, given the image quality requirements over the whole field of view. The optical system comprises (figure below):

- a telescope of focal length 1.082 mm and aperture f/3.5,
- three dichroic prisms located at the focus for spectral separation in the plane perpendicular to the orbital track,
- a rotating mirror, located in front of the telescope, for off-setting the pointing angle.

This system offers two major advantages:

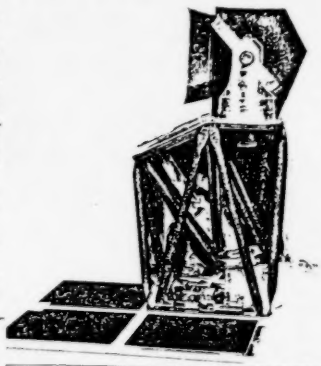
- the «exposure» time for each ground point imaged is automatically maximized,
- the mechanical simplicity of the instrument ensures images of excellent geometrical quality.

Push-broom scanning is only possible with a suitable linear array of detectors located in the instrument focal plane. A ground resolution of 20 m over a 60-km swath requires an array of 3 000 detectors, while a ground resolution of 10 m over the same swath width requires 6 000 detectors. These requirements can be met using charge-coupled device (CCD) detectors. More than one thousand discrete CCD detectors can be incorporated into a single linear array chip.

Only one preamplifier is required to condition and preamplify the signals generated by an entire linear array since image-generated charge packets are shifted serially.

The table below gives brief technical data concerning the SPOT HRV instruments:

swath width	60 km
spectral bands	0.5 - 0.59 μm (XS) 0.61 - 0.69 μm (20 m) 0.79 - 0.90 μm (P) 0.5 - 0.9 μm (10 m)
angle pointing offset capability	$\pm$ 26° in steps of 0.6°
rate of change of pointing angle	4°/s
data rate	8 (XS) (linear gain)24 M bps
radiometric sensitivity (noise equivalent reflectance difference)	$\simeq$ 0.5 % for $\theta_s \leq 60°$ (θs = solar zenith angle)



HRV INSTRUMENT
SMALL SCALE STRUCTURAL MODEL

As illustrated in *figure 14*, it is the pivoted mirror that makes it possible to obtain stereo pairs of images at an interval of one day.

DETECTORS

For each spectral band, a set of linear array elements is used to transform the in-coming light into a sampled video

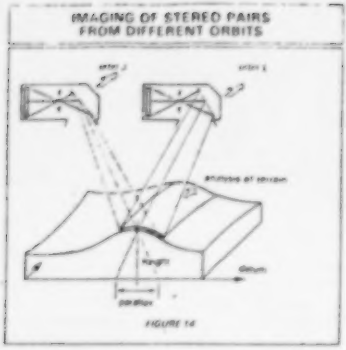


FIGURE 14

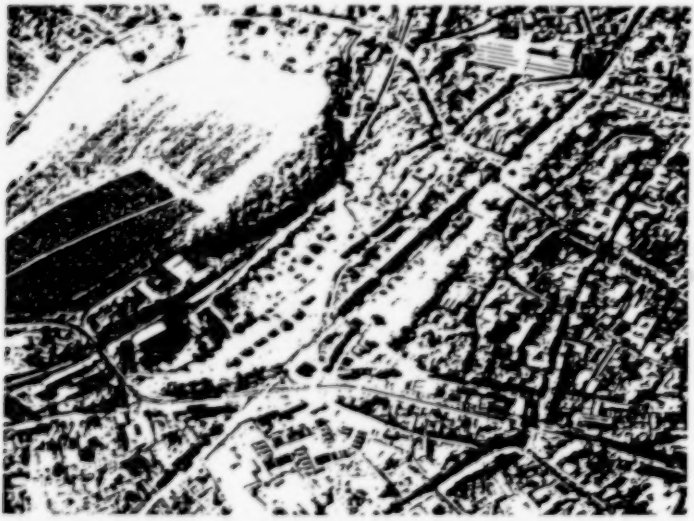
signal. The amplifier gain can be adjusted by ground command to ensure that the best possible use is made of all the dynamic range of the encoder. Adjustment is necessary as a function of the angle of incidence of sunlight on the terrain being imaged.

The instrument design described above is based on the use of CCD linear arrays in which the individual detectors are each 13 μm width.

Various innovations incorporated into the design had, however, to be studied and fully proven before the final design phase. Two instruments based on the «push-broom» principle were thus designed and developed for airborne tests. One instrument incorporated a 500-detector linear array, the other an array comprising 1 728 detectors.

These instruments were designed and the prototypes developed at the CNES Toulouse Space Center. The first tests were conducted in the Spring of 1976 and an aerial campaign was conducted in late July of the same year onboard a B-17 operated by the Institut Geographique National. The following photograph was taken in October 1977 in the Amiens region in northern France ; it represents uncalibrated data.

These results plus those obtained during laboratory tests and further recent trials justify the high hopes that are held for such systems when used for space-borned remote sensing.



What is Mapsat?

(By Alden P. Colvocoresses, U.S. Geological Survey)

INTRODUCTION

For nearly 8 years Landsat satellites (originally designated ERTS) have been imaging the Earth from space. The Landsat program is well documented [1, 2, 3] and has established remote sensing from space as a recognized discipline throughout the world. The latest Landsat (Landsat-3) carries cameras of 30-m resolution [1] as compared to 80+ m for Landsat-1 and -2; even so, Landsat is a relatively low-resolution system and is thus limited with respect to detailed study of the Earth. Moreover, Landsat is limited to the orthographic (near-vertical) viewing of the Earth which precludes the stereoscopic mode essential to the delineation of the third (elevation) dimension of the surface. Satellites other than Landsat have recorded the Earth's thermal response (Heat Capacity Mapping Mission) and radar response (Seasat); also, innumerable photographs have been taken of the Earth from manned spacecraft. However, with the exception of the very-low-resolution meteorological satellites, Landsat is the only system which can provide nearly global continuous coverage and thus has some of the characteristics of an operational system as compared to other systems which must be classed as experiments. The acceptance and use of Landsat data clearly indicates that there is a need for a truly operational Earth-sensing system, and that this need is global and not restricted to any one country or group of countries. This need has been recognized by Presidential Directive NSC-54 dated November 16, 1979, which assigned the management responsibility for civil operational land remote-sensing activities to the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce. Moreover the directive states that initially, the operational land remote-sensing system from space will be based on Landsat technology. How long it will take for the United States to develop a truly operational system depends on many factors, but at least the organizational structure has now been defined. It should also be noted that several foreign governments and agencies including the United Nations are considering the development of operational remote-sensing systems. From all indications, and operational Earth-sensing satellite system or systems will evolve during the 1980's. Because of the high cost involved, it is hoped that such systems will evolve on an international basis—perhaps similar organizationally to the global communications system—rather than each concerned country developing its own system.

U.S. GEOLOGICAL SURVEY POSITION

On September 21, 1966, Secretary of the Interior Stewart Udall announced the creation of the EROS program to study the Earth and its natural resources and environment from space. Secretary Udall and USGS Director William Pecora called for an appropriate satellite system—NASA responded by building, launching, and operating the Landsat series.

Since 1966, the USGS through its EROS program has played a key role in the development and utilization of Earth-sensing systems. Moreover, the EROS Data Center of the USGS is the only U.S. sales facility which distributes Landsat data on a global basis. The USGS has actively encouraged the Earth-sensing concept since 1966 with the view of seeing an operational system evolve. However, no government agency has had the authority to develop an operational system, and this is one reason why none has evolved.

With the promulgation of NSC-54, the management responsibility for the operational system now rests with NOAA, but the USGS and other agencies will make vital contributions to the system. For example, after nearly 10 years of the study of Landsat and its precursors, USGS has conceptually defined a candidate operational Earth-sensing satellite system. This system is known as Mapsat.

MAPSAT

On April 3, 1980, the USGS awarded a $200,000 contract to ITEK Corporation with TRW as subcontractor. This contract is of 8 months duration and is for a feasibility study of the conceptual design for an automated mapping system (Mapsat).

Mapsat is an effort by USGS to define an operational system. It is based on Landsat and includes the following concepts:

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[1] The term resolution as used herein refers to the effective resolution element which is defined as the instantaneous field-of-view of the sensor element coupled with the estimated spread function of the sensing system.

Global coverage on a continuous basis.
Open data dissemination in reasonable time and at reasonable cost.
Variable resolution, swath-width, stereoscopic and multispectral capabilities.
Capability of 1:50,000-scale image mapping with a 20-m contour interval.
Continuity with respect to Landsat-1, -2, and -3 including the same data transmission rates (15 megabits per second).
Cost effectiveness.

Details relative to Mapsat are covered in other papers [4 and 5] but a few points warrent elaboration.

Mapping geometry. The name Mapsat implies a mapping system, but this does not mean its primary function is to serve the mapmaker. Disciplines such as geology, hydrology, agriculture, geography, and engineering, to name a few, require multispectral data in accurate mappable form. Raymond Dideriksen (written commun., 1976) of the U.S. Soil Conservation Service has stated, "Until the geometric accuracy and resolution are greatly improved, we cannot consider Landsat or LFO (Landsat Follow-On) to be competitive cartographic tools whem compared with either high-altitude photography or cameras such as those that were demonstrated in Skylab." Here a Department of Agriculture spokesman is calling for a space system of higher geometric fidelity and resolution, and it is hard to conceive of any other serious user to whom geometry is not important. Geometric precision, which is essential to the cartographer, is also the key to an operational Earth-sensing system, and thus the name "Mapsat" has been applied. The products envisaged from Mapsat are not limited to conventional planimetric and topographic maps but include thematic displays and digital data extractions which have been demonstrated from Landsat data or which can be derived from digital elevation data.

The high geometric fidelity of Mapsat is achieved by defining a spacecraft and sensor system having virtually no moving parts and very precise position and attitude determination. The sensor system is based on solid-state linear arrays rather than mechanical scanners such as used on Landsat. Moreover, the antennas and solar panels are defined to remain rigid during data acquisition.

Resolution and data rates. Mapsat is designed for operation using various spectral bands at varius resolutions and swath widths. Areas requiring high resolution may be so covered with an effective resolution element as small as 10 meters. Fortunately these areas are generally of limited extent. Spectral band and stereo combinations would also depend on the type of area to be covered. However, a limitation on the data transmission rate is essential. By using data compression techniques and on-board data storage, the current data handling capacity of Landsat receiving stations (15 megabits per second) should be adequate.

Spectral bands. The Landsat multispectral scanner (MSS) uses four basic spectral bands, not including the thermal band on Landsat-3 which failed soon after launch. Of the four MSS bands, two are in the near infrared and are largely redundant. In order to optimize data acquisition against demonstrated practical use, the two near-infrared bands have been consolidated into one for Mapsat. The three bands selected are a bluegreen (0.47 to 0.57μm), a green-red (0.57 to 0.70μm) and a near-infrared (0.76 to 1.05μm) band. A thermal band, although important, is not considered suitable for Mapsat which records reflected solar energy. The thermal emissions from the Earth surface can best be measured at pre-dawn and afternoon to separate the Sun's effects. Thus a satellite other than Mapsat is needed for thermal sensing.

Stereoscopic capability. The delineation of the Earth's surface in three dimensions is essential for many uses. Landsat fails to record the third dimension of height, but Mapsat will definitely do this with two separate base-height ratios, depending on the type of topography involved.

The value of steroscopic sensing does not end with the production of topographic maps. The stereo mode provides for the automated production of digital elevation data, which is a relatively new and powerful tool for depicting and analyzing the Earth's terrain. With it the computer can depict topography based on any simulated conditions of illumination which is of high importance for geologic interpretation and related applications. Moreover, derivative products such as slope maps and the simulation of live radar images, such as can be obtained from an aircraft, can also be generated by the computer.

One-dimensional data processing. Data processing has been the Achilles' heel of Earth-sensing satellite systems. In a Landsat MSS scene approximately 10,000,000 picture elements (pixels) must be processed to produce an image. This requires a large computer, complex programs, and associated high cost. Mapsat is designed to acquire a one-dimensional flow of data from each detector in the linear array. The data from each of the several thousand detectors can be processed by relatively simple computer programs in a one-dimensional mode.

Two arrays of detectors are involved during stereo imaging, but by controlling spacecraft rotational rates corresponding detectors from the two arrays follow the same ground path. This is known as the epipolar plane condition by which the data from the two arrays are correlated and result in providing elevation data as well as planimetric position. Epipolar plane scanning is already applied to conventional steromodels by analytical plotters such as the Bendix AS–11B–X. Some ground control is needed, but with the stability and positional accuracy expected of Mapsat, such control need be but a very small fraction of that required for conventional photogrammetry. The correlated data can be processed by automated means and thus provide the basis for an automated mapping system. The proper implementation of this concept would greatly reduce data processing time and costs.

CONCLUSION

Parameters for Mapsat were first published in April 1979[4]. Since then some minor modifications have developed and the ongoing feasibility study will provide other changes. However, the basic concepts have been studied in considerable detail and the following conclusions reached:

The orbital parameters of Landsat 1, 2, and 3 are considered optimum for an Earth-sensing satellite, and the Landsat data transmission rate of 15 megabits per second is believed adequate.

Solid-state linear arrays promise to simplify the problem of multispectral imaging of the Earth from space.

The epipolar plane condition can be achieved with a properly designed Earth-sensing satellite, and this will permit the delineation of the third dimension of height using linear arrays producing one-dimensional data flows. Moreover, this condition will permit the automated processing of stereo data into topographic information.

An Earth-sensing satellite can now be built with virtually no actuated parts and thus achieve an expected long life and increased cost effectiveness as compared to existing systems.

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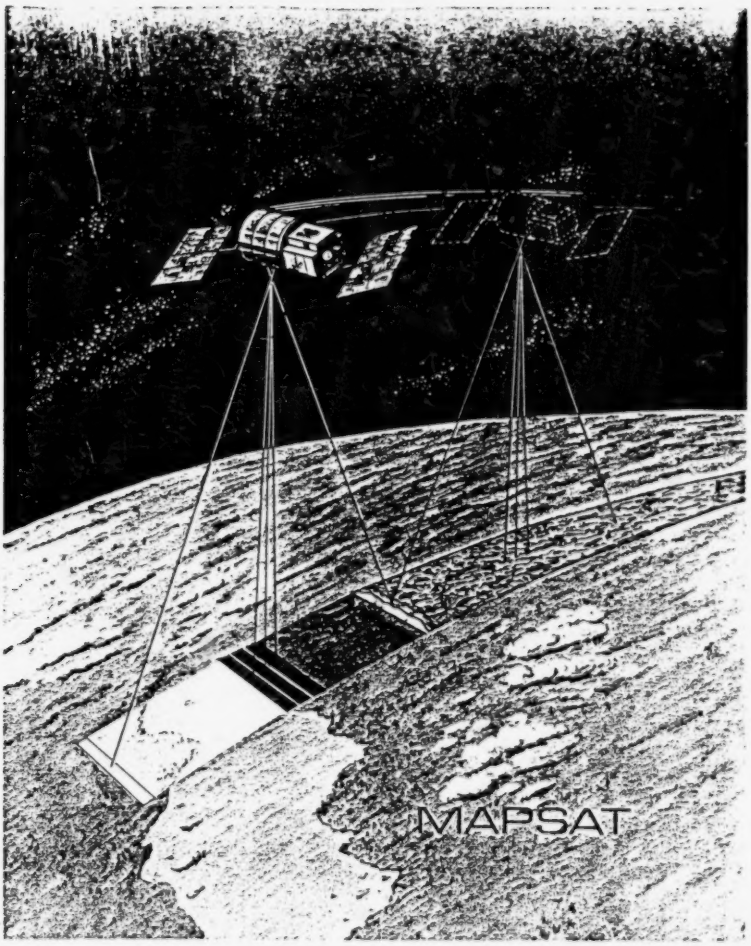
MAPSAT

Questions of Senator Heflin and the Answers Thereto

Question. Is there a substantial commercial market for land remote sensing data and interpretive services?

Answer. The market for Landsat frames from the EROS Data Center runs at about a $2.5–3M annual rate. This is far less than required to justify private investment in a satellite system. No one knows where the market would support a larger dollar volume for either Landsat or better data products, because no one has tested the market. Since the price of entry is low, however, many firms operate successfully in the value-added market for remote sensing interpretive services.

Question. Have adequate analyses of present and future commercial and government markets been made?

Answer. No. In the first six months of 1980, EROS Data Center statistics show the average availability of Landsat data to be more than four months after acquisition. Current users thus appear able to apply imagery over four months old, with a limited number of spectral bands. Many of these users are concerned with topographic applications (for geologic exploration and cartography) which would benefit from higher resolution and stereo. Since data products with significantly improved geometric quality are not generally available from space at a price which includes the cost of acquisition, the magnitude of this market is uncertain.

The thrust of new Landsat developments is to improve the timeliness of data distribution and number of spectral bands. As an experiment to determine if these qualities will enhance the use of remote sensing for applications such as agricultural forecasting, the improved Landsat is certainly worthwhile. Whether an operational system addressing this application will achieve a viable market depends on its costs vs. the cost of competing techniques, such as refined use of meteorological data or the country agent system in the U.S. Economic comparisons in this context need to be made.

Most U.S. government users are concerned only with domestic areas which are already covered regularly (every 1 to 3 years) by remote sensing aircraft. As satellite data with greater coverage per frame approach the quality of aerial imagery, substitution may be possible if the cost of satellite coverage is competitive. On a world wide scale, the economics of satellite coverage should be more favorable, but the only U.S. agency with substantial interest in foreign remote sensing is the Defense Department. These factors have not been adequately treated in surveys of the potential Federal market published to date, nor have the commercial for foreign governmental markets for high quality satellite data been assessed.

Whether even industry could perform a useful market analysis at this time, given the uncertainty in user demand, is questionable. Lacking user experience with a variety of product qualities priced to cover acquisition costs, there are practically no hard data on which to base demand projections. Development of such a data base should be a primary objective of NOAA's Transition Plan.

Question. Should the government define the performance and physical characteristics of an operational remote sensing system, or should industry?

Government and industrial data users should specify both data product requirements and value in future surveys. The commercial developer of an operational system should then optimize system design for maximum return on investment. Without experience which indicates the worth of various data products, however, the world-wide user community is unable to specify product values which could ultimately become commitments to buy.

Question. What considerations of foreign competition are involved in the question of private sector participation in an operational remote sensing system?

Answer. Certainly a foreign system which delivered a product of competitive quality at a lower (subsidized) price could undercut the market for a U.S. commercial system and obviate the objective of commercialization of the space segment. The U.S. should first direct its efforts toward providing products of superior quality. Second, the State Dept. should attempt to obtain protocols which limit the subsidies applied by foreign governments to their competitive space remote sensing programs. Failing this effort, the U.S. must consider supporting a commercial system with an assured demand which preserves a U.S. presence in the field.

Question. What effect would existing government facilities such as the EROS Data Center have on private sector ownership of the operational system, and should the government divest itself of such facilities?

Answer. A private initiative in remote sensing must consider assimilation of not only the EDC but existing communications and processing facilities emplaced for Landsat. Whether these facilities will be economic to continue can only be determined by analysis in the context of overall venture startup and operating costs. If they are not taken over by a commercial operator, then they should be shut down or dispositioned to non-competitive uses.

Question. What effect does the presence of the many foreign Landsat ground stations have on your thinking?

Answer. To achieve maximum world-wide use of its product, a commercial operator would probably encourage and expand the number of foreign user terminals able to receive remotely sensed data. The supply of terminal equipment and the training of operators could be a substantial market in its own right. Operational costs could be assessed on the basis of use of the satellite sensors, much as communications users are now charged a basic price per channel plus time on line. An operational system should be compatible with existing station equipment so that past investments will not be lost.

Question. How should the government assure the private sector that it will not compete in areas where private sector initiatives in land remote sensing take place?

Answer. Public law already prohibits government agencies from competing with private aerial survey operators in acquiring domestic coverage. The government must preserve its prerogatives to acquire foreign reconnaissance data and even to take over operation of the commercial system in the interest of national security, but a legal basis must be established which extends the competitive prohibition from aerial to space remote sensing.

Question. Are there any exclusive rights required to enable practical participation by a private sector entity in an operational land remote sensing system?

Answer. If any receipient of remotely sensed data is free to copy and distribute it, then the full cost of system operations must be burdened on the first few frames sold. A fairer distribution of costs would be obtained if the costs of data acquisition were spread evenly to all users of the product. The extension of international copyright conventions to cover unauthroized reproduction of remotely sensed data could protect the system operator and other users from erosion of the market or inequitable cost distribution.

Question. Is legislation needed to encourage private sector participation in an operational remote sensing system?

Answer. If private participation is to include substantial private investment, then new legislation is probably required in several areas identified in response to previous questions: prohibiting government competition and extending copyright protection, specifically. Other requirements for legislation or regulative interpretation will doubtless arise as a venture takes form. The whole question of regulation needs clarification; commercialization could be expedited if a single Federal office were designated to regulate commercial remote sensing under terms of applicable law such as the Outer Space Treaty of 1967.

Question. What do you see as the nature of the government's financial support required in this area in the various stages of evaluation of an operational land remote sensing system?

Answer. While a few technological issues remain to be solved by hardware development and demonstration, the principal prerequisite to commercialization of space remote sensing is to define and test the market with products of varying quality and price. Landsat alone is incapable of meeting this objective. During the 1980's, new sensors must be flown regularly with government support on the Space Shuttle and other spacecraft to develop a market data base. This will allow both governments (U.S. and Foreign) and private users to face the true costs and benefits of remote sensing. remote sensing.

Eventually, U.S. government users must be prepared to budget for consistent acquisition of products meeting their requirements. This implies long-term (5 to 7 years) contracts for purchase of data products, as opposed to individual buys of data tapes or frames. In addition, government-industry cooperation may allow mutual cost savings through use of common spacecraft mounting an array of both government-owned and privately-owned sensors.

Question. What involvement should the private sector have in the transition from the present experimental Landsat system to a fully operational land remote sensing system?

Answer. Private firms must be intimately involved in the cost-benefit studies leading to definition of operational data requirements. While competitive considerations will inhibit disclosure of ultimate system costs, relative magnitudes can be compared under modest system study contracts. To expand the market data base, government should encourage and fund industry proposals to evaluate a variety of sensing techniques on a multi-year demonstration basis. For example, regular operation of high-performance film cameras on the Space Shuttle could determine if, indeed, there is a market for data products with very high geometric quality even though distributed some time after acquisition.

By the late 1980's sufficient hard market data should be available to permit substantive industry proposals to furnish particular data products to the U.S. gov-

ernment under long-term contract. Such proposals presuppose consolidation and definition of a broader market of foreign government and commercial users.

Question. Does the question of private sector participation in an operational land remote sensing system need to be studied further? If so, who should sponsor and who should conduct such studies?

Answer. The objective of private sector operation of the remote sensing system as stated in PD-54 needs no further study. The means to achieve the objective remain to be defined cooperatively by government and industry. As a mechanism to expand knowledge of the market and applications, industry should be encouraged to come forward with proposals to demonstrate new capabilities on an interim operational basis. It is crucial to recognize that Landsat alone cannot justify private investment in remote sensing. Experience should be gained with a variety of data qualities and formats, provided by systems which fall within the state-of-the-art. Government/industry cooperation and even cost sharing may be possible in mounting demonstration and evaluation programs as precursors to eventual fully-commercial operations.

Question. What mechanisms should be set up to provide for industry inputs to the government now and during the period of transition?

Answer. With the designation of NOAA as cognizant agency for operational remote sensing, it is assumed that plans and demonstrations leading to operational system definition also fall under NOAA's cognizance. NOAA should be funded to support a diversity of system demonstration and evaluation activities not limited to Landsat. In particular, cost-sharing industry initiatives in the form of proposals to develop and fly demonstration systems on the Space Shuttle and other spacecraft should be encouraged, leading to real expansion of the market data base.

To ensure that paraochial government interests do not continue to inhibit system applications and development, a balanced review team should be established with representatives of both operators and data users, from both industry and government. Chairmanship of this committee should be vested in OSTP or OMB.

Question. What kind of financial incentives should the government provide to promote (private) sector involvement, and do you feel that you could depend on government commitments?

Answer. In the near term, government funds to support operational demonstrations with a diversity of sensors delivering a variety of product qualities will adequately stimulate industry initiatives. Eventual long-term government commitments to buy particular data products will be required. In general, industry can trust funded government contractual commitments and the consistency of broad policy statements. The annual budget process and the regulatory environment are subject to political pressures and are less dependable from year to year.

Senator STEVENSON. Thank you, Mr. Batchelder.

I do have some questions, and we might as well start with you.

For one thing, I don't understand all of your emphasis on film. What's the advantage of the high resolution cameras over the real time digital systems? Is it just a matter of cost?

Mr. BATCHELDER. Well, sir, it's a matter of cost. And there's a matter, at this point, even of feasibility.

If we were to try to acquire the kind of, shall we say, data rate, which is one way of describing the overall quality of an image with an electronic sensor, we'd be pushing the frontiers of what's achievable electronically.

There's no question there are benefits to the electronic system in terms of being able to bring back the data in a timely fashion and process it through a pipeline. But for applications such as mapping and geologic interpretation, where that pipeline doesn't have to be so short, it's much more economical to be able to bring back that information on film and take advantage of the extremely high data capacity of a film frame in lieu of trying to provide that same capacity through an electronic link.

Senator STEVENSON. Do you agree?

Dr. PUCKETT. The argument gets pretty technical, so I really shouldn't stretch it out.

Senator STEVENSON. That's why I asked.

Dr. PUCKETT. I think the use of film for certain very specific limited applications, say in a mapping application, where the data rate over a long period of time may be very low, you may redo your maps once every 5 years. Yet on the one occasion when you do it, film, in that case, has some attractions. But for most of the applications of the Landsat type of system, I think the continuous flow of real time electronically derived data probably makes more sense. That's my opinion.

Senator STEVENSON. Any further responses?

[No response.]

Senator STEVENSON. Dr. Puckett, I guess this really should be directed to you and Mr. Johnson. Representatives of user agencies this morning testified that it would be very difficult to aggregate their user requirements, to predict them. And their costs—if I understood you correctly, your model, your optimum model for private sector participation assumed the aggregation of such costs.

First, are the representatives of the user agencies wrong?

If not, what's your fallback?

Dr. PUCKETT. OK. I'll try that.

The user agencies today are using certain classes of data. So, if we take this particular snapshot in time, I could make a list of the data that they are using. There is a projected increase in the type and quality of data that would come about with the Landsat-D equipment. And I think the user agencies have participated in specifying their requirements for that. So, to that extent, they already have described in some way an aggregated market.

Now, what their needs might be 5 years beyond that, I think I would agree with them, that they can't foresee that today.

I think it would be difficult to state their requirements 10 years down the road. That's going to be an evolutionary process which represents that sort of classic interplay between what technology can offer, on the one hand, and what some potential user finds, in fact, is really useful, on the other. This is a perfectly classical example of the way in which new technology comes into being.

Remember, when the first communications satellites came into being in the early 1960's, that the major telecommunications companies of the world almost uniformly thought this was a fad and would have no impact at all on their real commercial operation. So, we're going through another similar process here that's going to take quite some time to sort out.

But I do think that from the standpoint of the usefulness—let's say a statement about data that would be useful to agencies at present, such a statement can be made and some reasonable projections can be made.

Now, as to the value of that data and how they pay for it, that's a different question. This is really the stickiest wicket in the whole affair, I think.

And, to a degree, I believe it will take, in effect, a statement of national policy regarding our intention to stay in the business for some period of time in order to make the process viable.

I really doubt that any one of the agencies today would be able to put a dollar value, as a result of some kind of financial analysis, on any particular item of data that it receives. That's very tough.

Senator STEVENSON. But that's what you need, isn't it? That's your bottom line.

Dr. PUCKETT. That would be the ideal situation, but there's another way to get there. If it is national policy that we continue in the remote sensing business, if it's national policy that we find some means of providing continuation of the kind of data we've been getting so far, then one way of doing it is for the Government to continue to buy satellites, either through NASA or through NOAA or through some other agency, and the cost of that complete system is assumed as a part of the national program, then the data is made available to all the agencies who want to use it, but the costs are not really allocated to the agencies in any strict accordance with the cost of the system.

So if the cost of a complete system is going to be borne by the Government in a continuing program of remote sensing, then we at least ought to look at the alternative of having the Government lease or contract for services from the private sector to see if those services can be procured at a cost less than they would otherwise incur in procuring directly the entire system.

So it doesn't really go to the question of cost/benefit at the agency level, but it represents the whole thing as a national program. I don't know if that answered your question.

Senator STEVENSON. Mr. Johnson, do you have something to add?

Mr. JOHNSON. Yes, Mr. Chairman. My answer is very much like that of Dr. Puckett.

I should say that I really can't take seriously the statements of user agency representatives that they could not determine what their real requirements will be. I realize that up to the present time they haven't been required to make such a determination because the whole Landsat program has been driven by other considerations. It has been a program within the NASA context for developing the technology and showing what can be done. The agencies, of course, have had the privilege of using the product of that system without having to determine their requirements in advance.

Now if we're serious about moving into an operational system, it seems to me that that approach is bound to be changed. I understand that while there isn't any precise commitment to involving the private sector in ownership and operation of a remote sensing system at any particular time, the Presidential statement—and previous expressions of interest by the Congress as well—all indicate that the U.S. Government is committed to continuity of data production by remote sensing systems. This is the point that Dr. Puckett was making.

If we look at this document, which I understand was developed in consultation and with the concurrence of other interested Government agencies, we see that it proposes to meet that requirement for continuity of data through the purchase of additional satellites by the Government of the Landsat-D or Landsat-D' type for the period of 1985 to 1989.

Now presumably that type of system would at least be responsive to those data requirements that the agencies think they would have during that time. Maybe it's more than responsive. Maybe it

does more than they want. But presumably it at least does what they think is essential.

The reason I say that is that I have noticed that the Assistant Secretary of Interior this morning expressed general concurrence and satisfaction with the plans that NOAA has for providing continuity of Landsat-type data through the 1980's. More specifically, the Department of Agriculture's witness this morning said this:

> So far as operation of the civil land observing system is concerned, we are pleased that the designated Federal operator, NOAA, has given consideration to the various capabilities and system characteristics which we feel are necessary to acquire data needed to carry out our missions.

Now that certainly sounds to me as though they've got an idea of what kind of data is needed to carry out their mission and that they are generally satisfied with the projections that NOAA has made for providing continuity of data by continuation of Landsat-D type satellites throughout the 1980's.

That being the case, we are proposing a fairly simple procedure which we've outlined in our statement; namely, let NOAA determine what the true cost is to the Government, utilizing the criteria set forth in the OMB circular, of establishing and operating that kind of a system, during that particular period, which presumably would be responsive to the requirements of Government agencies.

It's conceivable that the private sector might be able to respond to all the defined Government requirements with a satellite that differs substantially from Landsat-D. I'm not suggesting that's a realistic possibility. But I don't think the Government should simply say, "We are prescribing and specifying a Landsat-D type satellite." Perhaps it's most likely that the private sector in responding to a request for proposal would do so with a satellite that looks very much like Landsat D.

The real question is, what is the Government going to pay for continuing that system during that period and maintaining this continuity of data to which it is apparently committed as a matter of national policy? Let the Government fairly evaluate, in accordance with the principles of OMB circular 76, whether the private sector, having endeavored to put a realistic figure on what it can derive from nongovernmental sources, is able to provide that data to the Government at a lower cost than the Government would incur if it built and operated the system itself.

Senator STEVENSON. How would you respond to the concerns expressed by the States and local governments that data will not be available at a price they can afford?

Mr. JOHNSON. Mr. Chairman, I don't know what they really can afford. I suppose what they mean is that they expect the price to increase from what it presently is. But the NOAA document itself contemplates—in fact, I think it urges—the necessity of a more realistic pricing than prevails at the present time and moving toward a true and complete recovery of the Government's own cost.

Now, of course, if the Federal Government felt somehow that it was desirable to continue to provide data at a bargain basement cost to non-Federal Government units, it could include that factor in its own evaluation of whether a proposal from the private sector would save money or not. They could regard that, if they wished,

as a Government requirement. That is a public policy matter which I think is appropriate for the Congress to address.

There's no doubt about it; the private sector could not and would not continue—if it were free to price the product—to make it available on the present basis. I think that is inevitable if you move toward a truly operational system.

Senator STEVENSON. I have to go to vote again, and I don't want to keep you longer. You've been patient as it is. We do have some additional questions. You can answer them in writing for the committee.

Senator STEVENSON. Thank you very much. The committee is recessed. We have one more witness. We can reconvene, I hope, in about 5 minutes.

[Recess.]

Senator STEVENSON. The subcommittee will come to order. Our final witness is Mr. Samuel W. McCandless, Jr., of User Systems Engineering. I'm sorry we've kept you waiting so long, Mr. McCandless.

STATEMENT OF SAMUEL McCANDLESS, JR., USER SYSTEMS ENGINEERING, ANNANDALE, VA.

Mr. MCCANDLESS. I'd say your trip over and back was pretty fast. I'd like to thank the subcommittee for giving me the opportunity to come here today to talk about the transition plan.

To provide a little background on my perspective on this plan, I've been involved with space activities since I graduated from college, so I've done nothing else but be involved in space work for 22 years now. It's been my good fortune during that period of time to be the test director on the first lunar lander and more recently program manager at NASA on the Seasat program.

In 1978 I formed a company providing remote sensing services and sensor design, systems engineering, and applications and data analysis for private industry. I'm here today representing my fellow users that formed a group last year called the Ocean Commercial Users Association. This group is comprised of private sector people involved in offshore oil and gas exploration, development, and production; ocean mining; fishing; transportation and service organization that provide environmental and weather prediction for these groups.

At your request, I have reviewed the NOAA document, "Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options", dated June 20. I read the document over carefully, and I find that it's a comprehensive document. It considers most if not all of the options for running a civil remote sensing operation. It stresses system continuity as an important attribute of the system. Nearly all of the dimensions and legalities associated with revenues, pricing policies, and international considerations are addressed somewhere in the document.

But after considering the document and reading it, it's hard for me to determine whether we are merely transferring the job from one agency to another in lieu of trying to do land remote sensing in a fundamentally different way.

When the President issued Directive No. 54 last October, he transferred the management responsibility for civil and remote

sensing to NOAA and gave NOAA the task of finding ways to enhance private sector opportunities with the goal of private sector operation of civil land remote sensing activities. That's an important statement.

NOAA has suggested a course of action which is not congruent, I think, with this objective, and in my opinion will make the ultimate achievement of private sector involvement in this area nearly impossible. The establishment of new facilities, personnel, and systems design during the next 10 years—the so-called interim operational system in consonance with NOAA directed to major marketing and price policy—and continued application and test activities will escalate the Government's investment and involvement to the extent of precluding the true intent of PD–54 instead of willfully moving forward with the new approach geared to the commercial exploitation and expansion of this particular technology in space.

We are slowly considering all these dimensions and all of these aspects of an endless array of issues before we act. One thing I'd like to point out is that our foreign neighbors and competitors are becoming practitioners while we deliberate in this process. Many times we're stymied by fairness. We give data away at too low a cost. In fact, in some cases we're too fair to our foreign neighbors in giving our data away at extremely low cost.

I'd like to suggest a reversal of this trend. We should try a new approach with a practical transfer in the near term, not in 10 years, to private sector ownership and operation of a civilian Earth resource remote sensing system. I think this is the only way to develop markets for this kind of data and to test the data to find out how valuable it really is and to test the worth of specific system attributes.

I think this is the best and most direct approach to meet both private and public needs and to expand applications to business opportunities and to stimulate the design operation of the systems. I agree with the panel members before that it's highly likely that this galvanizing action will produce a leaner and more efficient organization and systems which will in turn reduce the net Federal expenditure for data and services.

I think it's important to realize that a cost reduction of this sort is really necessary at this point when the Government's money is not able to keep pace with the expanding needs. I think we need to find some way to provide leverage and get the private sector involved in this system. Unless we take this step, our competitors—many of them with stronger Government/private sector alliances—true partnerships—will outstrip us in shorter time periods in some important areas with smaller budgets.

We must reestablish our traditional will to pioneer, using the strengths of our free enterprise system.

There are a lot of examples of successful covenants between Government and the private sector—a lot of them are very old—but it should provide confidence that this approach and not costly delays is the best way to proceed. If we don't do this, I believe we are heralding a decade of complacency in space in the United States.

I'll provide some examples of that in other technology areas. I realize these are strong words, but I'd like to call your attention to historic areas of U.S. preeminence and leadership in areas of technology and businesses based on technology that are now waning. The steel industry, the auto industry, and now many of our electronic industries have been and are being challenged and surpassed. Predictions a few years ago that would have been dismissed are coming true, and there are more on the horizon.

Recently I have been involved in the evaluation of computer applications, and one of the things that surprised me when I looked at it is finding out that a lot of our largest computers—the very largest Cray and CDC computers are being purchased—a predominant number are being purchased by foreign governments. In fact, the foreign governments are applying these computational aids to aircraft design, weather forecasting, and a number of other practical problems. At the present time, the largest competing system—a system valuable for research in many of these complex areas—is currently being designed and is soon to be built by the Japanese.

Another example is that many important remote sensing techniques that have already been validated by proof of concept satellite programs such as Nimbus and Seasat lie dormant. It's important to ask the question why synthetic aperture radars, microwave scatterometers, and a host of other sensors are not now today in harness, producing data for private and public sector economic and social advantage.

A review of foreign satellite programs indicates that many of these technologies and ones that we haven't yet tried will be placed in space by others. Examples of this are the French SPOT satellites that will begin high-resolution stereo coverage of the Earth in 1983 and several Japanese and European space agency programs that include imaging radars and radiometers. In the same time frame, we have debated these areas and looked at these kinds of applications and finally abandoned somewhat similar initiatives.

I'd like to get to the heart of the matter now and suggest an alternative, because it's important, I think, to suggest an approach that I think would work.

The alternative that I suggest is an example of what we ought to do. It may not be the absolute best example, but I don't think that's the most important point. The most important point is to get on with it. I'm convinced that it beats the 10-year hiatus being suggested by the proposed plan.

The Government has an important role in the transition process, a very important role. The Government is the main user. It's a stimulator of R. & D. activities and should provide protection against unfair domestic and international pressures.

As a user, step No. 1, the Government—NOAA should define the Government's aggregate requirements for data collected by and derived from civilian remote sensing satellite systems and establish the total cost, considering the budgetary needs of each participating department and agency of creating and operating the system.

Step No. 2, given this information, proposals from the private sector should be requested. These proposals will be based on providing goods and services to the Government at agreed-upon rates and

volume with strong covenants protecting both the Government and private sector interests.

What should the Government covenants include? Well, as a minimum the Government must have assurances that the content and temporal value, timeliness of the data will comply with current and projected needs, and the private operator/owner must be assured that the Government will be a long-term customer, will not compete by providing similar products or restrict data use in important ways.

Many of these issues are treated in great deal in the subject document, but more important than a large document considering every issue are basic agreements and alliances that permit initiation without burdensome, hard-to-interpret regulation. Over-regulation will ultimately destroy the efficiencies inherent in the proposed system. Companies that would bid on this have to determine potential revenues which would be derived from non-Government users. That's something that they must do.

This step fosters innovative market development, acquisition strategies, financial arrangements, and a host of productive dimensions valuable to the Nation's economy by making the most of important technologies. This approach, if applied fairly with positive intent, would provide an acid test to determine whether a near-term transfer to the private sector is possible.

At present, I think we're carrying too much administrative overhead to make the strictly Government approach a profitable exercise. There will be some pain in this. Some inplace facilities, people, and nearly free services that are now provided would have to end. Extra-fair, low-cost arrangements with U.S. and foreign users would have to be renegotiated. There would doubtless be some pressures created by this approach, but these sacrifices are mild, I believe, if you consider the institutional entrenchment that will exist if this move is put off for another 10 years.

I'd like to change gears now in my testimony by discussing the way that the document was formulated and drafted that I evaluated. An important part is the document that was put out by the Japanese Government entitled "The Vision of MITI Policies in the 1980s," which provides an insight into how Japan's Ministry of International Trade and Industry views the future.

A point to consider here is that the way the document was created offers some revealing insights into how this particular country is attempting to shape its economic future. By intent and plan, many diverse people—including industry officials but also industrial professors, journalists, labor union leaders, and members of consumer groups—were participants—not recipients but participants in the authorship and drafting of the document.

By contrast, the document in question represents the erudite but fairly cloistered view of agency officials. NOAA has held a series of meetings to inform the public of their activities on this program and the NOSS program and to solicit comments from interested attendees, but I contend this is basically a controlled recipient relationship and not a participative alliance.

These activities cannot be presented as a comprehensive examination of user interests. Users were not and are not generally privy to NOAA's transition plan. Try as I might to get a copy of it—I was

very pleased to get a copy of it from you to evaluate, but it was very difficult to make arrangements to get a copy of it before. We tried.

The group that I help represent, the Ocean Commercial Users Association, is really currently on the outside looking in on many of these programs. A case in point is the National Oceanic Satellite System. NOAA has been asked to represent private sector interests in that important program, yet important users, members of the commercial community, and other people, other organizations, do not participate in a meaningful advisory capacity in the program.

There are a number of good examples of Government and private sector involvement. They're sort of pilot programs. They're not large programs, but I think that the work that NASA has done in some of their applications programs is laudable. On a very small investment, less than a million dollars by the Government, a system to provide data products to ocean users called the Satellite Data Distribution System was put together by NASA and the U.S. Navy at the Fleet Numerical Oceanographic Center. The system has been well received by the users, and we find it to be very helpful.

I find that the insular atmosphere used by NOAA to create the transition plan belies many of the statements in the plan. Particularly I take issue with the fact that a system that meets the stated needs of Federal, State, and local government users would be adequate for commercial purposes—that's an all-encompassing statement.

Material in the transition plan is cast as representing the most comprehensive survey of user requirements conducted to date. Again, I take issue with that since users were not participants in the plan.

Summing up, I feel that the lack of a working-level involvement in the framing and drafting of the transition plan makes its conclusions and recommendations suspect, and I recommend that the necessary legislation authorizing the Secretary of Commerce to develop, own, and operate U.S. civil operational land remote sensing satellite systems not be passed on the basis of the proposed plan.

In the final analysis, a gradual assimilation by the private sector, heavily regulated and controlled by an expanding self-sustaining Government organization is not the best way to put an already sizable Government to work for the good of the country and our economy.

Data from space has been analyzed by Government and private sector scientists in a number of pilot application experiments which verify that there are cost/benefit results and underline the potential value of space-based environmental data in many commercial areas.

But conducting pilot experiments is one thing. Creating a sustained, cooperative partnership—a real alliance—is another. We still lack reciprocal Government and private sector covenants in this area that assure a balanced mix of private and public benefits.

On the basis of the proposed plan, these covenants do not appear to be forthcoming. It would appear that Congress must take steps and create a more productive result. If interaction begins on a true

partnership basis, it is very possible that our space technology, something we've invested a lot of money in and are preemminent in at the moment, can be an example of a Government/private sector pioneering effort to take full advantage of this important technology.

Senator STEVENSON. Thank you, Mr. McCandless. You and other witnesses have suggested that the Government aggregate its data requirements. And the Government witnesses have said that those requirements are very difficult to predict.

How do you respond? Were you here when the user agencies were testifying?

Mr. MCCANDLESS. Just at the tail end of it.

Senator STEVENSON. Leaving aside the State Department, which explained that it was not a user agency, they all said it was very difficult if not impossible to predict their requirements and particularly the cost of their data requirements.

Mr. MCCANDLESS. I'd look at it a little differently. I'd say the Government is going to spend a lot of money on these programs. Congress is going to allocate a significant amount of money to them to keep this program going. That's what it's going to cost.

I think it's time to get some leverage in the private sector to see if they're willing to do the job, to provide the same goods and services for less money and, indeed, make a profit in the private sector, something that would be their responsibility.

I kind of looked at it. I thought that I had it. When I was asked to testify, I remember very vividly the evening the Russians launched sputnik I was a senior in college. I had a very dejected feeling. I wondered at the time, being an engineer, what we were going to do in response. Well, the rest is history; we responded and did a lot of grand things.

But in many ways, I think we're at a crossroads again. It's time to look at what we've done and find out whether or not we can get leverage in the private sector to actually get them involved in these activities. I think this is the time to do it. If you wait 10 years, it's not likely that it will happen. I think it will be institutionalized, entrenched, and will continue pretty much the way it has.

Senator STEVENSON. Well, the response that you mentioned was a Government response—Government managed, Government financed—and the civil space programs of other countries are Government programs, including Japan which you referred to with admiration. I share your feelings about MITI.

Mr. MCCANDLESS. But I do think there are firmer partnerships and alliances between the private sector and the Government in these cases. I really do. I think that they're going to make a profit and use these services in a different way in some cases.

The Government has an important role, and I emphasized that. I don't think the Government can get completely out of the R. & D. business; that's a very specialized area. But I think the Government has to support—the Government has to provide the protection. The Government is the key user, so the Government is not going to be out of the picture. I think NOAA has an important role in it, but I don't think the role ought to be to form the system

within the Government totally, to implement the system in the Government totally, or to proceed for the next decade on that path.

Senator STEVENSON. In the transition plan, NOAA proposes to assign the responsibility for managing the operational land remote sensing program to the National Earth Satellite Service. It will manage the civil operational meteorological satellite systems, the national oceanic satellite system, and the civil operational land remote sensing satellite system. However, NOAA's Environmental Data and Information Service will manage the land remote sensing satellite system archiving function and will disseminate Landsat's standard products to users with respect to data.

How do you view this division of responsibility within NOAA between the taking of the data and the archiving of it?

Mr. MCCANDLESS. Well, my experience in the past with NOAA is that their intentions are laudable, but there's a basic cultural gap between their understandings of the data and creation of the data. I think there needs to be some acid test of how the data is valuable before Government decides that they're going to change this particular channel or for whatever reason create a bigger spacecraft, create a data system that is structured in certain ways, maybe favoring Government use of the data.

My experience in the past has been that there's a basic cultural difference in their understanding of how the data should be ordered, how the data should be structured, and how it should be disseminated in terms of the timeliness of the data and the packaging of the data.

In the private sector, I think what would happen there—is that there would be lots of flexibility. There would be the ability to test what's valuable, what's salable. Certain things would disappear. If they weren't valuable or salable, they would cease to exist.

Senator STEVENSON. Wouldn't there be a big secondary market in the private sector, if it were controlled and disseminated by the private sector?

Mr. MCCANDLESS. I think so. We have a different situation here than we did for our communication satellite system where we had a market already. They were using wires and microwave relay systems.

But there's still a marketplace there. Here the marketplace is not as well defined, so the Government has got to be involved to the extent of helping them get started. But I believe the marketplace is there. I think that somebody's going to exploit it. Hopefully it will be us. It may not be us. There are areas right now where it's like our people, our miners and petro-explorers are going to be using data produced by SPOT and be paying for that.

[The statement follows:]

STATEMENT OF SAMUEL W. MCCANDLESS, JR., USER SYSTEMS ENGINEERING

I am pleased to appear before you today to discuss the "Transition Plan—For Civil Operational Land Remote Sensing From Space" prepared by the National Oceanic and Atmospheric Administration (NOAA).

At your request, I have reviewed the NOAA document "Planning For a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options", dated June 20, 1980. I find this document to be a carefully done and comprehensive compendium of the many issues and options that surround the civil operational land remote sensing program. System continuity is correctly assessed as an important key to user interest, market development and sustaining commercial

application. Nearly all of the dimensions, legalities and legislative issues associated with revenues, pricing policies and international considerations are addressed somewhere in the document. But, after considering all of the arguments and information, it is hard to determine whether we are merely transferring the job from one agency to another in lieu of trying to do Land Remote Sensing a fundamentally different way.

When the president issued Directive #54 last October, he transferred the management responsibility for civil land remote sensing to NOAA and gave NOAA the task of finding ways to enhance private sector opportunities with the goal of private sector operation of civilian land remote sensing activities. NOAA has suggested a course of action that is not congruent with this objective and, in my opinion, will make the ultimate achievement of private sector involvement nearly impossible. The establishment of new facilities, personnel and systems designs during the next ten years (a so-called Interim Operational System) in consonance with NOAA directed major marketing, price policy and continued application test activities will escalate government investment and involvement to the extent of precluding the accomplishment of the true intent of PD54.

Instead of willfully moving forward with a new approach geared to the commercial exploitation and expansion of our technology in space; we slowly consider every dimension and aspect of an endless array of issues before we act. Our foreign neighbors and competitors are becoming practitioners while we deliberate. It seems that we are becoming stymied by fairness, hopelessly mired down by the stultification of endless study and cautious to the extreme of trying out new ideas and systems only after years of delay. I suggest a reversal of this trend with a practical transfer, in the near term—by 1983—to private sector ownership and operation of a civilian earth resource remote sensing system. This is the only way to develop markets for this type of data and to truly test the worth of specific system attributes. I feel that this is the best and most direct approach to meet both private and public needs, expand applications and business opportunities, and to stimulate the design and operation of new systems. It is highly likely that this galvanizing action will produce leaner and more efficient organizations and systems that will in turn reduce the net federal expenditure for data and services. A cost reduction of this sort is necessary when the remotely sensed satellite data needs of the U.S. government are expanding more rapidly than are the budgets that support them.

Unless we take this step our competitors, with stronger government—private sector alliances, will out-strip us in shorter time periods with smaller budgets. We must re-establish our traditional will to pioneer using the strengths of our free enterprise system. Numerous examples of successful covenants between the government and the private sector should provide confidence that this approach, and not costly delays, is the best way to proceed. Instead of lengthy documents that raise endless questions, about how, why, when and who, we should adopt a simple and direct approach that can be scaled and changed as we learn from the successes and failures that will surely occur. If we don't do this, I believe we are heralding a decade of massive complacency in space for the United States. I realize that these are strong words. Alarming statements, and those who deliver them, are many times discounted and ignored.

However, I call your attention to historic areas of United States preeminence and leadership in areas of technology, and businesses based on these technologies, that are now waning. The steel industry, auto industries and now many of our electronic industries have been, and are being, challenged and surpassed. Predictions that a few years ago would have been dismissed are coming true and there are more on the horizon. A recent review of purchases of our largest computers reveal that they are being acquired and applied by other governments to solve aircraft design, weather forecasting and many other practical problems. The largest computational system, invaluable for researching many complex aircraft and weapons system design and applications analyses, is currently being constructed by the Japanese. Many important remote sensing techniques that we have already validated and demonstrated by "Proof of Concept" satellite programs such as NIMBUS and SEASAT lie dormant. Why aren't synthetic aperture radars, mocrowave scatterometers and a host of other sensors in harness producting data for private and public sector economic and social advantage? A review of foreign satellite programs indicates that many of these technologies, and ones that we haven't yet tried, will be placed in space by others. Examples of this are the French SPOT satellites that will begin high resolution stereo coverage of the earth in 1983, and several Japanese and European Space Agency Programs that include imaging radars. In the same time frame we have debated and finally abandoned similar initiatives.

The alternative that I will suggest, is an example of what we ought to do. It may not be the absolutely best approach, but that is not the most important point. I'm convinced that it beats the ten year hiatus begin suggested by the proposed plan.

The government has an important role in the transition process as a user, stimulator of R & D activities, and protection against unfair domestic and international pressures. As a user the government (NOAA) should define the governments aggregate requirements of data to be collected by and derived from civilian remote sensing satellite systems, and establish the total cost, considering the budgetary needs of each participating department and agency, of creating and operating a government-owned system. Given this information, proposals from the private sector should be requested. These proposasls will be based on providing goods and services to the government at an agreed-upon rate and volume with strong covenants protecting both government and private sector interests. The government must have assurances that the content and temporal value of the data will comply with current and projected needs, and the private operator/owner must be assurred that the government will be a long term customer, will not compete by providing similar products, or restrict data use in important ways. Many of these issues are treated in great detail in the subject document. More important than infinite and involuted precursors to system operation are basic agreements and alliances that permit initiation without burdensome, hard-to-interpret regulations. Overregulation will ultimately destroy the efficiencies and efficacy inherent in this important step to establish space remote sensing as a commercial profit producing venture. Interested companies must determine the potential revenues which would be derived from non-government users. This step fosters innovative market development/acquisition strategies, financial arrangements and has a host of productive dimensions valuable to the nation's economy by making the most of important technologies.

This approach, if it is applied fairly with positive intent, will provide an acid test to determine whether a near-term transfer to the private sector is possible. At present, we are carrying too much administrative overhead to make the strictly government approach a profitable exercise. Some inplace facilities, people and nearly free services would have to end. Extra fair, low cost, arrangements with U.S. and Foreign Users would have to be re-negotiated. There would doubtlessly be some pressures created by this approach, but these sacrifices are mild if you consider the institutional entrenchment that will exist if this move is put off for another decade.

I would like to change the perspective of my commentary and discuss the formulation of the subject document relative to systems users. One of the dictionary definitions important to the subject we are discussing is the word "vision", when used as the ability to perceive something that isn't actually visible, as through mental acuteness or keen foresight. This description characterizes a recent report entitled "The Vision of MITI Policies in the 1980's" which provides an insight into how Japan's Ministry of International Trade and Industry views the future. At a time when many Americans are agonizing over their nations economic performance, this document, and the way it was created, offers some revealing insights into how another country is attempting to shape its economic future. By intent, many diverse people, including ministry officials, industrialists, professors, journalists, labor union leaders and members of consumer groups were participants in the authorship and drafting of this document. By contrast, the document in question represents the erudite but fairly cloistered views of agency officials. NOAA has held a series of meetings to inform the public of their activities and to solicit comment from interested attendees. I contend that this is basically a controlled recipient relationship and not a participant alliance. These activities cannot be presented as a comprehensive examination of user interests. Users were not and are not generally privy to NOAA's transition plan. The group that I participate with and help represent, the Ocean Commercial Users Association "OCUA" is currently on the outside looking in on important remote sensing programs.

A case in point is the National Oceanic Satellite System—NOSS. NOAA has been tasked to represent private sector interests in this important program. Yet, important users, members of OCUA and other interested commercial interests and organizations, do not participate in a meaningful advisory capacity.

There are important examples of successful government private sector alliances on space remote sensing programs. NASA's applications experiments are laudable efforts in this arena and the "Satellite Data Distribution System—(SDDS)" established by the U.S. Navy and NASA is a working testimony to what can be accomplished by decision and implementation. The SDDS, located at the Navy's Fleet Numerical Oceanographic Center in Monterey, California, provides satellite and conventionally derived oceans data to ocean transport, mining, fishing, oil and gas, and related service organizations. An important aspect of the government private sector agreement is that trial or pilot applications experiments are fully funded by

the commerical group participating in exchange for the data supplied via a government access system, the SDDS. The funds expended to date, less than one million dollars over a four year period, are small compared to the value derived from this type of government/private sector interaction.

In light of these comparative interactions, I find that the insular atmosphere used by NOAA to create the transition plan belies many of the statements in the plan.

"A system that met the stated needs of federal, state and local government users would be adequate for commercial purposes"

Material in the transition plan—"represents the most comprehensive survey of user requirements conducted to date".

I feel that the lack of a working level involvement in the framing and drafting of the transition plan makes its conclusions and recommendations suspect.

I recommend that the necessary legislation authorizing the secretary of commerce to develop, own and operate U.S. civil operational land remote sensing satellite systems not be passed on the basis of the proposed plan.

In the final analysis, a gradual assimilation by the private sector heavily regulated and controlled by an expanding, self sustaining, government organization is not the best way to put an already sizeable government investment to work for the good of the country and our economy.

For over twenty years our government has applied a generous amount of its vast scientific, technological and economic resources to space-based remote sensing. This country has developed its industrial, technical and economic base from many programs that government initiated and stimulated. But the widespread and productive use of these technologies depend on government/private sector cooperative efforts.

Existing technologies and facilities can be used productively by the private sector. This commercial application of remote sensing data products and services follows the precepts of our free enterprise system. More importantly, private sector use of space remote sensing now should follow earlier patterns where broad technologic assimilations have paced national productivity and even survival.

Data from space have been analyzed by government and private sector scientists in many pilot application experiments, which verify cost/benefit results and underline the potential value of space-based environmental data in many commercial areas.

But conducting pilot experiments is one thing and creating sustained cooperative partnerships is another. We still lack reciprocal government and private sector covenants that assure a balanced mix of private and public benefits.

On the basis of the proposed plan these covenants do not appear to be forthcoming. It would appear that congress must take steps to change the current direction and create a more productive result. If interactions begin on a true partnership basis then another government/private sector pioneering effort at technology exploitation can begin.

[The following information was subsequently received for the record:]

QUESTIONS OF THE COMMITTEE AND THE ANSWERS THERETO

Question. How is it possible for the French to launch a remote sensing satellite system using multi-linear array technology by 1983?

Answer. The basic building blocks of a linear array sensor are:

The solid state multi-element array;

A collector system that places the array or arrays in a focal plane; and

An optical system used to direct and concentrate the natural earth radiation on the collector.

The degree of difficulty of sensor system design and manufacture is generally a function of the desired Instantaneous Field of View (picture element dimension), measurement sensitivity (gray level discernable), dynamic range (total measurement range or number of gray levels) and the number of wavelengths on spectral bands grouped in one sensor.

The French spot system, and earlier stereosat studies sponsored by NASA, considered one or at most two spectral bands and fairly modest levels of the parameters listed above. Certainly performance goals that are well within demonstrated and available technologies and systems.

The so-called "Multi-Linear Array" being considered by NASA is a significant step beyond these systems. It is in reality a "Multi-Spectral Linear Array" requiring new device or solid state elements covering a variety of wavelengths, a highly efficient collector system based on a multi-beam splitter that divides incoming

radiant energy with low losses, and a complex optical system to collect and focus the energy.

The French, and indeed the United States, can produce and launch the simplier system in the early to mid 1980's without significant invention or innovation.

Question. It seems the same term—Multi-Linear Array—is used to define two different kinds of technology. Is the U.S. Multi-Linear Array instrument contemplated superior to the French contemplated spot instrument?

Answer. The performance of United States Mulit-Spectral Linear Array sensor is more ambitious than the French spot design and requires some new developments in device and collector technololgies coupled with an innovative optical design.

Question. What does it mean to say the French spot system will have high resolution stereo coverage? Will it have high resolution spatial coverage? Spectral coverage? Radiometric coverage?

Answer. The term high resolution usually means spatial resolving capability. In the classic sense it means the ability to separately discriminate between closely spaced targets. Although the precise meaning is not the same, the figures quoted as resolution are often the Instantaneous Field of View (IFOV) of the sensor. In the case of a linear array sensor, the IFOV is the dimension of a single photo diode element optically translated to the ground plane.

Senator STEVENSON. Thank you very much, Mr. McCandless. We have some additional questions which you can answer for the record. The subcommittee is adjourned.

[Whereupon, at 12:55 p.m., the hearing was adjourned.]

ADDITIONAL ARTICLES, LETTERS, AND STATEMENTS

[The following material was referred to on p. 1]

[From the Office of the White House Press Secretary, June 20, 1978]

THE WHITE HOUSE

The President directed under a Presidential Review Memorandum that the NSC Policy Review Committee (PRC) thoroughly review existing policy and formulate overall principles which should guide our space activities. The major concerns that prompted this review arose from growing interaction among our various space activities.

This review examined and the resultant presidential Directive establishes:

A government policy oversight system to review and revise space policy as needed;

Ground rules for the balance and interaction among our space programs to insure achievement of the interrelated national security, economic, political, and arms limitation goals of the U.S.; and

Modifications to existing policies, the appropriate extent of the overlapping technology, and product dissemination by the sectors.

This Presidential Directive establishes an NSC Policy Review Committee to provide a forum to all Federal agencies for their policy views, to advise on proposed changes to national space policy, to resolve issues referred to the committee, and to provide for rapid referral of issues to the President for decision as necessary. This committee will be chaired by the Director of the Office of Science and Technology Policy, Frank Press. Recognizing that the civilian space program is at the threshold of change, the President has asked the PRC to access the needs and aspirations of the nation's civil space program. The United States has built a broad national base in space and aeronautics. At issue is how best to capitalize on prior investments and set the needed direction and purpose for continued vitality in the future.

Under the Presidential Review Memorandum the emphasis was to resolve potential conflicts among the various space program sectors and to recommend coherent space principles and national space policy. In focusing upon these issues, the Policy Review Committee concluded that our current direction set forth in the Space Act of 1958 is well founded and that the preponderence of existing problems was related to interactions and resultant stresses among the various space programs. For this reason, the classified portion of the recently signed Presidential Directive concentrates on overlap questions. It does not deal in detail with the long-term objectives of our defense, commercial, and civil programs. Determining our civil space policy, outlined above, will be the next step.

As a result of this in-depth review, the President's Directive establishes national policies to guide the conduct of United States activities in and related to space programs. The objectives are (1) to advance the interests of the United States through the exploration and use of space programs and (2) to cooperate with other nations in maintaining the freedom of space for all activities which enhance the security and welfare of mankind. The space principles set forth in this Directive are:

The United States will pursue space activities to increase scientific knowledge, develop useful commercial and government applications of space technology, and maintain United States leadership in space technology.

The United States is committed to the principles of the exploration and use of outer space by all nations for peaceful purposes and for the benefit of all mankind.

The United States is committed to the exploration and use of outer space in support of its national wellbeing.

The United States rejects any claims to sovereignty over outer space or over celestial bodies, or any portion thereof, and rejects any limitations on the fundamental right to acquire data from space.

The United States holds that the space systems of any nation are national property and have the right of passage through and operations in space without interference. Purposeful interference with space systems shall be viewed as an infringement upon sovereign rights.

The United States will pursue activities in space in support of its right of self-defense and thereby strengthen national security, the deterrence of attack, and arms control agreements.

The United States will conduct international cooperative space activities that are beneficial to the United States scientifically, politically, economically, and/or militarily.

The United States will develop and operate on a global basis active and passive remote sensing operations in support of national objectives.

The United States will maintain current responsibility and management relationships among various space programs, and, as such, close coordination and information exchange will be maintained among the space sectors to avoid unnecessary duplication and to allow maximum cross-utilization of all capabilities.

Our civil space programs will be conducted to increase the body of scientific knowledge about the earth and the universe; to develop and operate civil applications of space technology; to maintain United States leadership in space science, applications, and technology; and to further United States domestic and foreign policy objectives within the following guidelines:

The United States will encourage domestic commercial exploitation of space capabilities and system for economic benefit and to promote the technological position of the United States; however, all United States earth-oriented remote sensing satellites will require United States government authorization and supervision or regulation.

Advances in earth imaging from space will be permitted under controls and when such needs are justified and assessed in relation to civil benefits, national security, and foreign policy. Controls, as appropriate, on other forms of remote earth sensing will be established.

Data and results from the civil space programs will be provided the widest practical dissemination to improve the condition of human beings on earth and to provide improved space services for the United States and other nations of the world.

The United States will develop, manage, and operate a fully operational Space Transportation System (STS) through NASA, in cooperation with the Department of Defense. The STS will service all authorized space users—domestic and foreign, commercial and governmental—and will provide launch priority and necessary security to national security missions while recognizing the essentially open character of the civil space program.

Our national security related space programs will conduct those activities in space which are necessary to our support of such functions as command and control, communications, navigation, environmental monitoring, warning and surveillance, and space defense as well as to support the formulation and execution of national policies; and to support the planning for and conduct of military operations. These programs will be conducted within the following guidelines:

Security, including dissemination of data, shall be conducted in accordance with Executive Orders and applicable directives for protection of national security information. Space-related products and technology shall be afforded lower or no classification where possible to permit wider use of our total national space capability.

The Secretary of Defense will establish a program for identifying and integrating, as appropriate, civil and commercial resources into military operations during national emergencies declared by the President.

Survivability of space systems will be pursued commensurate with the planned need in crisis and war and the availability of other assets to perform the mission. Identified deficiencies will be eliminated and an aggressive, long-term program will be applied to provide more assured survivability through evolutionary changes to space systems.

The United States finds itself under increasing pressure to field an anti-satellite capability of its own in response to Soviet activities in this area. By exercising mutual restraint, the United States and the Soviet Union have an opportunity at this early juncture to stop an unhealthy arms competition in space before the competition develops a momentum of its own. The two countries have commenced bilateral discussions on limiting certain activities directed against space objects, which we anticipate will be consistent with the overall U.S. goal of maintaining any nation's right of passage through and operations in space without interference.

While the United States seeks verifiable, comprehensive limits on anti-satellite capabilities and use, in the absence of such an agreement, the United States will vigorously pursue development of its own capabilities. The U.S. space defense program shall include an integrated attack warning, notification, verification, and

contingency reaction capability which can effectively detect and react to threats to U.S. space systems.

[From the Office of the White House Press Secretary, Oct. 11, 1978]

THE WHITE HOUSE—FACT SHEET: U.S. CIVIL SPACE POLICY

The President announced today a space policy that will set the direction of U.S. efforts in space over the next decade. The policy is the result of a four-month interagency review requested by the President in June 1978. American civil space policy will be centered around three tenets:

First: Our space policy will reflect a balanced strategy of applications, science and technology development containing essential key elements that will:

Emphasize space applications that will bring important benefits to our understanding of earth resources, climate, weather, pollution and agriculture, and provide for the private sector to take an increasing responsibility in remote sensing and other applications.

Emphasize space science and exploration in a manner that retains the challenge and excitment and permits the nation to retain the vitality of its space technology base, yet provides short-term flexibility to impose fiscal constraints when conditions warrant.

Take advantage of the flexibility of the space shuttle to reduce the cost of operation in space over the next two decades to meet national needs.

Increase benefits for resources expended through better integration and technology transfer among the national space programs and through more joint projects when appropriate, thereby increasing the return on the $100 billion investment in space to the benefit of the American people.

Assure American scientific and technological leadership in space for the security and welfare of the nation and continue R&D necessary to provide the basis for later programmatic decisions.

Demonstrate advanced technological capabilities in open and imaginative ways having benefit for developing as well as developed countries.

Foster space cooperation with nations by conducting joint programs.

Confirm our support of the continued development of a legal regime for space that will assure its safe and peaceful use for the benefit of mankind.

Second: More and more, space is becoming a place to work—an extension of our environment. In the future, activities will be pursued in space when it appears that national objectives can most efficiently be met through space activities.

Third: It is neither feasible nor necessary at this time to commit the United States to a high-challenge space engineering intiative comparable to Apollo. As the resources and manpower requirements for shuttle development phase down, we will have the flexibility to give greater attention to new space applications and exploration, continue programs at present levels or contract them. To meet the objectives specified above, an adequate Federal budget commitment will be made.

SPACE APPLICATIONS

As a part of his overall review and in accordance with his desire to increase emphasis on uses of space for a wide variety of practical and economic benefits the President made the following decisions:

Remove sensing systems.—Since 1972 the United States has conducted experimental civil remote sensing through LANDSAT satellites. There are many successful applications and users, including Federal departments, other nations, a number of states, and a growing number of commercial organizations. The United States will continue to provide data from the developmental LANDSAT program for all classes of users. Operational uses of data from the experimental system will continue to be made by public, private, and international users. Specific details and configurations of the LANDSAT system and its management and organizational factors will evolve over the next several years to arrive at the appropriate technology mix, test organizational arrangements, and develop the potential to involve the private sector.

Integrated remote sensing system.—A comprehensive plan covering expected technical, programmatic, private sector, and institutional arrangements for remote sensing will be explored. NASA will chair an interagency task force to examine options for integrating current and future systems into an integrated national system. Emphasis will be placed on defining and meeting user requirements. This task force will complete its review prior to the FY 1981 budget cycle.

Weather satellites.—Separate operational requirements for meteorological data over the past two decades have led to separate Defense and Commerce's National

Oceanic and Atmospheric Administration (NOAA) weather satellites. The Defense community, NASA, and NOAA will conduct a review of meteorological satellite programs to determine the degree to which these programs might be consolidated in the 1980s and the extent to which separate programs supporting specialized defense needs should be maintained. The possibility of integrated systems for ocean observations from space will also be examined.

The private sector.—Along with other appropriate agencies, NASA and Commerce will prepare a plan of action on how to encourage private investment and direct participation in civil remote sensing systems. NASA and Commerce will be the contacts for the private sector on this matter and will analyze proposals received before submitting to the Policy Review Committee (Space) for consideration and action.

Communications satellite R. & D.—United States leadership in communications satellite systems will be supported by NASA. Selected technological opportunities to provide better frequency and orbit utilization and other longer-term opportunities will be pursued.

Communications satellite services.—Some areas of communications services—such as educational and health services and basic communications services for remote areas—involve low-volume and intermittent use and have evidenced little interest from commercial satellite operators. The Department of Commerce's National Telecommunications and Information Administration (NTIA) will assist in market aggregation, technology transfer, and possible development of domestic and international public satellite services. This direction is intended to stimulate the aggregation of the public service market drawing on the technology that is already in existence. The Agency for International Development and Interior will work with NTIA in translating domestic experience in public service programs into potential programs for lesser-developed countries and the remote territories.

Future applications and economic activity.—It is too early to make a commitment to the development of a satellite solar power station or space manufacturing facility due to the uncertainty of the technology and economic cost-benefits and environmental concerns. There are, however, very useful intermediate steps that will allow the development and testing of key technologies and experience in space industrial operations to be gained. The United States will pursue an evolutionary program that is directed toward assessing new options which will be reviewed periodically by the Policy Review Committee (Space). The evolutionary program will stress science and basic technology—integrated with a complementary ground R&D program—and will continue to evaluate the relative costs and benefits of proposed activities.

SPACE SCIENCE AND EXPLORATION

The President reviewed the space science and planetary exploration program and determined that the United States' priorities at any given time will depend on the promise of the science, the availability of the particular technology, and the budgetary situation. The United States will maintain a position of leadership in space science and planetary exploration and will:

Continue a vigorous program of planetary exploration to understand the origin and evolution of the solar system. The goal in the years ahead is to continue the reconnaissance of the outer planets and to conduct more detailed exploration of Saturn, its moons, and its rings; to continue comparative studies of the neighboring planets, Venus and Mars; and to conduct reconnaissance of comets and asteroids.

Utilize the space telescope and free-flying satellites to usher in a new era of astronomy, as we explore interstellar molecules, quasars, pulsars, and black holes to expand our understanding of the universe.

Develop a better understanding of the sun and its interaction with the terrestrial environment through space systems—such as the Solar Maximum Mission and the Solar Polar Mission—that will journey towards the sun and earth-orbiting satellites that will measure the variation in solar output and determine the resultant response of the earth's atmosphere.

Utilize the space shuttle and spacelab, alone and in cooperation with other nations, to conduct basic research that complements earth-based life science investigations and human physiology research.

Our policy in international space cooperation will include two basic elements: (1) to pursue the best science available regardless of national origin and expand our international planning and coordinating effort; and (2) to seek cooperative support for experiments-spacecraft which have been chosen on sound scientific criteria.

INCREASED BENEFIT FOR RESOURCES EXPENDED

As a result of the President's review, decisions were made that will increase the benefit to the United States for resources expended.

Strategy to utilize the shuttle.—The Administration will make incremental improvements in the shuttle transportation system as they become necessary. Decisions on extending the shuttle's stay time in orbit and future upper stage capabilities (e.g., the reusable space tug and orbital transfer vehicle) will be examined in the context of our emerging space policy goals. An interagency task force will make recommendations on what future capabilities are needed. The task force will submit the findings to the Policy Review Committee (Space) prior to the FY 1981 budget cycle.

Technology Sharing. The Policy Review Committee (Space) will take steps to enhance technology transfer between the space sectors. The objective will be to maximize efficient utilization of the sectors while maintaining necessary security and current management relationships.

Background

Early in his Administration, the President directed a National Security Council review of space policy. The emphasis was on coherent space principles and national space policy and did not deal in detail with the long-term objectives of our defense, commercial, and civil programs. The review, completed in May 1978, resulted in a Presidential Directive that set the basic framework for our civil space policy completed last week. The President's May 1978 directive established a Policy Review Committee (Space) to provide a forum for all Federal agencies in which to advise on proposed changes to national space policy and to provide for rapid referral of issues to the President for decision. This Committee is chaired by the Director of the Office of Science and Technology Policy, Frank Press. In June 1978 the President directed the Policy Review Committee (Space) to assess the future needs of the nation's civil space program, and their report formed the basis for the policy decisions outlined here. The following agencies and departments participated: the National Aeronautics and Space Administration, Commerce, Interior, Agriculture, Energy, State, National Science Foundation, Agency for International Development, Defense, Director of Central Intelligence, Joint Chiefs of Staff, and Arms Control and Disarmament Agency, as well as the Domestic Policy Staff, the National Security Council Staff, and the Office of Management and Budget.

THE WHITE HOUSE,
Washington, D.C., November 16, 1979.

Presidential Directive/NSC-54

To: The Secretary of State, the Secretary of Defense, the Secretary of Interior, the Secretary of Agriculture, the Secretary of Commerce, the Secretary of Transportation, the Secretary of Energy, the Director, Office of Management and Budget, the Assistant to the President for Domestic Affairs and Policy, the Administrator, Agency for International Development, the Director, Arms Control and Disarmament Agency, the Chairman, Joint Chiefs of Staff, the Director of Central Intelligence, the Administrator, National Aeronautics and Space Administration, the Administrator, Environmental Protection Agency, the Director, Office of Science and Technology Policy, and the Director, National Science Foundation:

Subject: Civil Operational Remote Sensing. (U)

The President has approved the civil space policy discussed below. The policy amplifies that established in PD/NSC-37—National Space Policy and PD/NSC-42—Civil and Further National Space Policy. (U)

[Delete.]

2. Land programs

The National Oceanic and Atomospheric Administration (NOAA) of the Department of Commerce is assigned the management responsibility for civil operational land remote sensing activities in addition to its ongoing atmospheric and oceanic responsibilities. Initially, the operational land remote sensing system from space will be based on LANDSAT technology. Commerce's initial responsibility—in coordination with other appropriate agencies—will be to develop a time-phased transition plan covering: (1) a Program Board (discussed below); (2) organization for management and regulation; (3) system financing including pricing policies for the users sharing of costs; (4) technical programs; (5) establishment of private and international participation; (6) identification of facilities (including the EROS data center), hardware, and personnel that should be transferred; and (7) identification of actions such as executive orders and legislation required. Commerce will submit to OMB a

preliminary implementation plan by December 15, 1979, covering any required fiscal year 1981 budget adjustments and a final transition plan by June 1, 1980. (U)

(a) Federal management mechanism.—Commerce will establish and chair a Program Board for continuing federal coordination and regulation with representatives from the involved federal organization (e.g., Defense, Interior, Agriculture, Transportation, Energy, State, NASA, CIA, AID, EPA and EOP). Organizations such as the National Governors' Association and National Conference of State Legislatures will be asked to participate as necessary. The Board will forward recommendations on unresolved policy issues to the Policy Review Committee (Space) for consideration and action. (U)

(b) Private sector involvement.—Our goal is the eventual operation by the private sector of our civil land remote sensing activities. Commerce will budget for further work in FY 1981 to seek ways to enhance private sector opportunities (e.g., joint venture with industry, a quasi-government corporation, leasing, etc.). Commerce will be the contact for private industry on this matter and with the Program Board will analyze any proposals received prior to submitting policy issues to the Policy Review Committee (Space) for consideration and action. (U)

(c) International participation.—The United States will generally support nondiscriminatory direct readout to foreign ground stations to continue our present policy and to provide data to foreign users under specified conditions. Pricing policies must be developed that are consistent for foreign and domestic users. We will promote development of complementary nationally operated satellite systems so as to limit US program costs, but protect against unwarranted technology transfer. (U)

3. Weather programs

Defense and Commerce will maintain and coordinate dual polar orbiting meteorological programs. We will continue procurement of current satellite systems with Defense and Commerce each operating separate satellites to meet the differing needs of the military and civil sectors. When any new polar orbiting satellites are justified they will be jointly developed and procured by Defense, Commerce and NASA to maximize technology-sharing and to minimize cost. An appropriate coordination mechanism will be established to assure effective cooperation and to prevent duplication. (U)

4. Ocean programs

If a decision is made to develop oceanographic satellites, joint Defense/Commerce/NASA development, acquisition and management will be pursued. A Committee will be established, with the above representation expanded to include State, CIA, and NSF. The Committee will forward recommendations on policy issues to the Policy Review Committee (Space) for consideration and action. (U)

ZBIGNIEW BRZEZINSKI.

[From the Office of the White House Press Secretary, November 20, 1979]

THE WHITE HOUSE

The President today announced the designation of the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) to manage all operational civilian remote sensing activities from space. This designation is one of several policy decisions announced today after a review of civilian space policy mandated by a Presidential Directive in October, 1978.

Early in his administration, the President directed a comprehensive review of space policy. The review, completed in May, 1978, resulted in a Presidential Directive that established a national space policy framework. It created a Policy Review Committee on Space, chaired by the Director of the Office of Science and Technology Policy, Frank Press. One of the tasks of the Policy Review Committee has been to assess the Nation's future civil space remote sensing requirements. That review was the basis for the policy decisions announced today.

Designation of a single agency, NOAA, to manage all civil operational satellite activities will lend itself to further integration and potential cost saving in the future. NOAA's experience in successfully operating and managing three generations of weather satellites prepares it to assume the responsibility for land remote sensing in addition to its ongoing atmospheric and oceanic activities. NOAA's first action will be to develop a transition plan in coordination with other appropriate agencies for moving to a fully integrated satellite-based land remote sensing program.

Initially, our operational land remote sensing efforts will rely on experience derived from the LANDSAT program. LANDSAT was begun in 1972 by NASA as a satellite effort specifically designed to observe surface features of the earth.

The President's decision establishes a three-part framework to serve remote sensing activities:

Integration of civilian operational activities under NOAA.

Joint or coordinated civil/military activities where both parties' objectives can be best met through this approach.

Separate defense activities which have no civilian counterpart.

Other space policy decisions developed by this review and announced today are:

The Commerce Department will seek ways to further private sector opportunities in civil land remote sensing activities, through joint ventures with industry, a quasi-government corporation, leasing, etc., with the goal of eventual operation of these activities by the private sector.

We will continue the policy of providing LANDSAT data to foreign users, and promoting development of complementary and cooperative nationally operated satellite systems so as to increase benefits for all nations.

The Department of Commerce will establish and chair a Program Board for continuing federal coordination and regulation of civil remote sensing activities. The involved federal organizations will be represented (i.e., the Departments of Defense, Interior, Agriculture, State, Transportation, and Energy, and NASA, CIA, AID, and EPA). The National Governors' Association and the National Conference of State Legislatures will be invited to participate.

Separate weather programs for the military and civil sectors will be maintained under the Departments of Defense and Commerce because of their differing needs. We will continue procurement of current spacecraft until development of a new system design is justified. Future polar orbiting satellite development and procurement will be jointly undertaken by Defense, Commerce and NASA to maximize technology-sharing and minimize cost.

Ocean observations from space can meet common civil and military data requirements. Accordingly, if we decide to develop ocean satellites, joint Defense/Commerce/NASA management of the program will be pursued.

NATIONAL SECURITY COUNCIL
Washington, D.C., April 18, 1980

Hon. ADLAI E. STEVENSON,
U.S. Senate, Washington, D.C.

DEAR SENATOR STEVENSON: Although our staffs have been in touch since, I wish to respond formally to your request of March 7 for the instructions given in Presidential Directive 54. In the Directive, the President approved the civil space policy described below:

1. Overall direction

The United States' interests in remote sensing from space will be served by a three-part structure: (1) separate defense activities which have no civilian counterpart; (2) joint or coordinated civil/military activities where both objectives can be satisfied without compromising national policy; and (3) integration of civil operational activities under single civil agency management with coordination and regulation by an interagency board. Joint management and overall system convergence will not be pursued between classified space activities necessary for intelligence and unclassified civil space remote sensing.

2. Land programs

The National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce is assigned the management responsibility for civil operational land remote sensing activities in addition to its ongoing atmospheric and oceanic responsibilities. Initially, the operational land remote sensing system from space will be based on LANDSAT technology. Commerce's initial responsibility—in coordination with other appropriate agencies—will be to develop a time-phased transition plan covering: (1) a Program Board (discussed below); (2) organization for management and regulation; (3) system financing including pricing policies for the users' sharing of costs; (4) technical program; (5) establishment of private and international participation; (6) identification of facilities (including the EROS date center), hardware, and personnel that should be transferred; and (7) identification of actions such as executive orders and legislation required. Commerce will submit to OMB a preliminary implementation plan by December 15, 1979, covering any required fiscal year 1981 budget adjustments and a final transition plan by June 1, 1980.

(a) Federal management mechanism.—Commerce will establish and chair a Program Board for continuing federal coordination and regulation with representatives from the involved federal organizations (e.g., Defense, Interior, Agriculture, Transportation, Energy, State, NASA, CIA, AID, EPA, and EOP). Organizations such as the National Governors' Association and National Conference of State Legislatures will be asked to participate as necessary. The Board will forward recommendations on unresolved policy issues to the Policy Review Committee (Space) for consideration and action.

(b) Private sector involvement.—Our goal is the eventual operation by the private sector of our civil land remote sensing activities. Commerce will budget for further work in fiscal year 1981 to seek ways to enhance private sector opportunities (e.g., joint venture with industry, a quasi-government corporation, leasing, etc.). Commerce will be the contact for private industry on this matter, and with the Program Board will analyze any proposals received prior to submitting policy issues to the Policy Review Committee (Space) for consideration and action.

(c) International participation.—The United States will generally support nondiscriminatory direct readout to foreign ground stations to continue our present policy and to provide data to foreign users under specified conditions. Pricing policies must be developed that are consistent for foreign and domestic users. We will promote development of complementary nationally-operated satellite systems so as to limit U.S. program costs, but protect against unwarranted technology transfer.

3. Weather programs

Defense and Commerce will maintain and coordinate dual polar orbiting meteorological programs. We will continue procurement of current satellite systems with Defense and Commerce each operating separate satellites to meet the differing needs of the military and civil sectors. When any new polar orbiting satellites are justified, they will be jointly developed and procured by Defense, Commerce, and NASA to maximize technology-sharing and to minimize cost. An appropriate coordination mechanism will be established to assure effective cooperation and to prevent duplication.

4. Ocean programs

If a decision is made to develop oceanographic satellites, joint Defense/Commerce/NASA development, acquisition, and management will be pursued. A committee will be established, with the above representation expanded to include State, CIA, and NSF. The committee will forward recommendations on policy issues to the Policy Review Committee (Space) for consideration and action.

I regret the inadvertent delay in responding and hope you find the information given above useful.

Sincerely,

CHRISTINE DODSON,
Staff Secretary.

[The following material was referred to on p. 3]

THE SECRETARY OF COMMERCE,
Washington, D.C.

Hon. ADLAI E. STEVENSON,
Chairman, Subcommittee on Science, Technology, and Space, Committee on Commerce, Science, and Transportation, U.S. Senate, Washington, D.C.

DEAR ADLAI: I am pleased to submit to you a Department of Commerce discussion document entitled "Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options." These issues and options are being given careful consideration by the Administration in its development of the fiscal year 1982 budget and legislative programs. We would welcome your views, and those of the members of your Subcommittee, on these issues and options as specific proposals for legislation and funding of the operational system are being formulated.

One of the key issues to be resolved by the Federal government is when to initiate an operational system that is fully responsive to the data requirements of users at a cost that users are willing to pay. The timing of the development of such a fully operational system will depend to a large degree on the willingness of users, including Federal agency users, and the private sector to invest in the operational system. Until a decision is reached on the design and funding of the fully operational system, the Federal government will rely on the existing NASA-planned Landsat D system with any extensions or improvements which may be necessary in order to meet the Administration's commitment to continuity of data during the 1980s.

The Department of Commerce looks forward to testifying before your Subcommittee on the issues and options involved in the development of a civil operational land remote sensing satellite program.

Sincerely,

PHILIP M. KLUTZNICK,
Secretary of Commerce.

Enclosure.

PLANNING FOR A CIVIL OPERATIONAL LAND REMOTE SENSING SATELLITE SYSTEM: A DISCUSSION OF ISSUES AND OPTIONS

TRANSMITTAL

To assist in the discussion of the establishment of a civil operational land remote sensing satellite program, the Commerce Department has prepared this document entitled "Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options." These issues and options are being given careful consideration by the Administration in its development of the fiscal year 1982 budget and legislative program.

One of the key issues to be resolved by the Federal government is when to initiate an operational system that is fully responsive to the data requirements of users at a cost that users are willing to pay. The timing of the development of such a fully operational system will depend to a large degree on the willingness of users, including Federal agency users, and the private sector to invest in the operational system. Until a decision is reached on the design and funding of the fully operational system, the Federal government will rely on the existing NASA-planned Landsat D system with any extensions or improvements which may be necessary in order to meet the Administration's commitment to continuity of data during the 1980s.

EXECUTIVE SUMMARY

This document discusses the issues and options relating to a national civil operational land remote sensing satellite system pursuant to the President's decision to assign to the National Oceanic and Atmospheric Administration of the Department of Commerce the management responsibility for civil operational land remote sensing satellite activities.[1] This document, prepared by the Commerce Department (Commerce), in coordination with other interested agencies,[2] discusses the issues involved in implementing an operational land remote sensing system from space, initially based on Landsat technology, with the goal of eventual private sector ownership and operation of the system. Some policy and technical options related to implementing an operational system are contained in this document, but decisions on these options will, for the most part, await the Administration's fiscal year 1982 budget review and subsequent actions.

A land remote sensing satellite system provides information about the condition of the Earths' surface by a process of sensing radiation from objects on the Earth. The systems uses sensors located on satellites which transmit the data to ground receiving stations for processing into usable data products. The current system is largely an experimental program called Landsat managed by the National Aeronautics and Space Administration (NASA). Information from the system has proven of value to a variety of public and private sector users in the United States and abroad for helping to make decisions related to such areas as agricultural crop forecasting, rangeland, and forest management, mineral and petroleum exploration, mapping, urban and regional land use planning, water quality assessment and disaster assessment.

Background

The issuance of the President's decision regarding civil operational remote sensing from space culminated a two-year Administration review of the nation's space policy. During this period, the Policy Review Committee (Space) was established and national policy on space programs was clarified. In May 1978, the President announced that the United States will encourage domestic commercial exploitation of space capabilities under appropriate U.S. authorization and supervision. Further, in October 1978, the President made a commitment to continue the availability of data from the Landsat program for all classes of users. In his March 27, 1979, Science

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[1] The White House Press Release of November 20, 1979, announcing this decision is appended to this summary at Attachment A.

[2] The National Aeronautics and Space Administration, the Departments of Agriculture, the Interior, Energy, State, and Defense, the Agency for International Development, the Environmental Protection Agency, and the Director of Central Intelligence.

and Technology Message, the President reiterated his Administration's commitment to the continuity of land remote sensing satellite data over the coming decade. Subsequently, Dr. Frank Press, the President's Science Advisor, in Administration testimony before the Senate Subcommittee on Science, Technology, and Space on April 9, 1979, stated "the Administration is committed to an operational remote sensing system, although yet underfined."

From October 1978, through the summer of 1979, Executive Branch agencies examined the potential for integrating U.S. civil remote sensing satellite programs and for private sector involvement in U.S. civil space activities. They recommended that all U.S. civil operational remote sensing programs be managed by a single agency. The agencies also reported that the private sector would be interested in assuming more responsibility for land remote sensing from space if Federal policy and market uncertainties were clarified.

In November 1979, the President provided the Framework within which a civil operational land remote sensing satellite system should be implemented, and assigned to the National Oceanic and Atmospheric Administration (NOAA) in Commerce the management responsibility for civil operational land remote sensing activities in addition to its ongoing atmospheric and oceanic responsibilities. NOAA's related ongoing responsibilities include managing the national civil operational meteorological satellite program and the Commerce Department's responsibilities for a joint operational demonstration by the Department of Defense (DoD), NASA and Commerce of a National Oceanic Satellite System (NOSS).

The Executive Branch's review of remote sensing satellite programs and policies was paralleled by a series of Congressional hearings during the 96th Congress on operational land remote sensing from space, including hearings before the House Subcommittee on Space Science and Applications of the Committee on Science and Technology and the Senate Subcommittee on Science, Technology and Space of the Committee on Commerce, Science and Transportation. Two bills before the 96th Congress focused on operational land remote sensing: S. 663, introduced by Senator Adlai E. Stevenson, which proposed the establishment of an Earth Data and Information Service in NASA, and S. 875, introduced by Senator Harrison Schmitt, which proposed the creation of a for-profit Earth Resources Information Corporation.

Assumptions

This document was developed in accordance with the following assumptions, which reflect the policies, established in the President's decision on civil operational remote sensing and previous space policy pronouncements, and the prerequisites to their achievement:

The Federal government will ensure continuity of data during the 1980s;

A national civil operational land remote sensing satellite system should ensure continuity of data and the appropriate reliability and timeliness of standard data products;

User requirements, projected levels of demand and the cost of meeting these requirements should determine the design of the operational system;

The Administration's goal is eventual private sector ownership and operation of the operational system, which includes the assumption of financial risk, as well as operational control by the private operators;

Prices for land remote sensing satellite products should be set at levels that ensure maximum recovery of system costs consistent with the public good;

The practice of the widest practical dissemination of Landsat data on a public nondiscriminatory basis will be continued for the data and standard data products from the Interim and Fully Operational Systems in accordance with prevailing U.S. national policies;

Eventual private sector ownership and operation of the U.S. program will be conducted under Federal government regulation, consistent with U.S. policies and international obligations;

The civil operational land remote sensing satellite program is a national program responsive to Federal interests and U.S. user requirements. Due regard will be given to foreign user interests and to foreign participation in the U.S. program;

NOAA will manage the operational system until a new institutional framework is established.

The present Landsat system

The existing Landsat system consists of one satellite, Landsat 3, launched in 1978, which covers the Earth once every 18 days and transmits sensed data from an on-board multi-spectral scanner (MSS) and two return beam vidicon (RBV) cameras back to Earth, either directly to U.S. or foreign ground stations or indirectly from an on-board tape recorder which stores data until the satellite is within range of a

U.S. ground station. NASA's Goddard Space Flight Center controls the satellite and performs the initial preprocessing of the data transmitted to Goddard from U.S. ground stations via domestic communications satellite (DOMSAT).

At the Department of the Interior's EROS Data Center in Sioux Falls, South Dakota, the Goddard preprocessed high density digital tapes are archived and further processed into standard data products (either computer compatible tapes or photographic images) for dissemination to domestic and foreign users at the cost of processing the order and reproduction. Similar preprocessing, processing, archiving and dissemination functions are performed by the nine foreign ground stations that now receive data direct from Landsat 3.

Two additional satellites, Landsat D and D', currently are under construction, with Landsat D tentatively planned for launch in 1982. The Landsat D series of satellites is designed to carry a new sensor, the Thematic Mapper (TM), which will provide 30m resolution[3] for the first time, as well as the MSS, and to use the Tracking and Data Relay Satellite System (TDRSS) for relay of data direct from Landsat to a single U.S. ground station at White Sands, New Mexico. To provide continuity with data from previous Landsats, the multispectral scanner (MSS), which provides 80m resolution, will continue to be deployed on Landsat D and D'. Direct readout of sensor data to foreign ground stations will be continued.

Because of difficulties in developing the TM and the associated ground data processing system, NASA is considering launching Landsat D without TM in 1982, to be followed by Landsat D' with TM later.[4] Current estimates for the operational preprocessing of Landsat D and D' data at Goddard are 200 MSS scenes per day beginning no earlier than 1983 and up to 50 TM scenes per day when the TM system becomes operational possibly no earlier than 1985.

The interim and fully operational systems

A fully operational land remote sensing system that meets optimal performance standards can be implemented at the earliest in 1989, given best estimates of the state of the are advances in sensors and the time required for Federal contracting procedures if they are used. Until that time, extension of the Landsat D system can ensure that, after 1983, the commitment to continuity of data during the decade of the 1980s is met.

From a technical standpoint, the following performance standards have been identified as applicable to a high quality operational system:

Sensors designed to generate data meeting a broad range of user requirements at a reasonable price;

Assured continuity of satellite coverage without break, with one backup satellite in orbit at all times and another on the ground;

Ninety-five percent confidence that, averaged over a two-day period, all data will be processed and made available from the ground station within 48 hours of receipt; and

Ability to identify and process certain data out of order to meet urgent user needs.

However, the extent to which these compatibilities are pursued will depend upon their full capital and operating costs and the demonstrated existence of an adequate private and Federal market to justify such costs.

While sensors specifically designed to generate data meeting a broad scope of user requirements cannot be provided until the late 1980s, the Landsat D sensors can be used as the basis for an interim system which will help to ensure continuity of data during the 1980s and meet many user needs.

The Administration is currently reviewing the Landsat D system to see where improvements may be required to ensure data continuity during the 1980s. For instance, the current Landsat system includes no satellites after Landsat D'. Anticipated gaps in spacecraft coverage of several years between about 1986 and the initiation of a fully operational system may have to be filled by the construction of one or more satellites or by the refurbishment of Landsat D. In addition, changes in the Landsat D ground segment may be required to minimize the risk of losing some data or having an excessively long delay in processing some data. The Landsat D system, with any follow-on satellites and ground system improvements, has been designated the "Interim Operational System."

The earliest possible date by which all four performance standards for a high quality operational system could be met is 1989, when the R&D necessary for the new solid state, multilinear array sensors should have been completed, and the

[3]The term "resolution", as used in this document, refers to the instantaneous field of view (IFOV).

[4]The administration is also considering other alternatives such as delaying the launch of Landsat D until 1983 when the TM sensor will be ready.

sensors will have been fabricated, tested, and incorporated into either an existing multi-mission modular spacecraft (MMS) or a new spacecraft. The Landsat D system so modified is designated the "Fully Operational System."

A decision on when to implement the Fully Operational System requires careful examination of the Federal Government's priorities, needed financial assistance, private sector willingness to invest in and take over the system, user demands during the interim system and the potential risk of foreign satellite systems obtaining a portion of the domestic and foreign land remote sensing market.

Management arrangements for the interim operational system

Certain changes in management responsibility will take place as the Interim Operational System is implemented. Although the exact dates for transferring managerial responsibility to NOAA are subject to changes in NASA's schedule for Landsat D, NOAA plans to assume the following responsibilities from NASA and Interior on the following schedule:

NOAA will assume responsibility from NASA in fiscal year 1983 for the command and control of the system and will begin providing MSS data on an operational basis after the successful launch and check-out of Landsat D and the MSS ground system and after NASA has demonstrated that the system is operational. NOAA will assume responsibility for TM data when that portion of the system reaches an initial operational level of performance;

NOAA will assume responsibility from NASA and the EROS Data Center in fiscal year 1983-84 for the generation and dissemination of data and standard data products. Assuming it is cost-effective, a new facility would be co-located with the Landsat D preprocessing facility at Goddard and would be the sole sales outlet in the United States of data and standard data products from the Interim Operational System; and

NOAA will take title to the Landsat archival material at Goddard and the EROS Data Center in fiscal year 1984 and will be responsible for archival and dissemination functions for the Interim Operational System.

During the interim operational phase based on the Landsat D series of satellites, NOAA will manage the system in coordination with an interagency Assistant Secretary level Program Board. In addition, the Secretary of Commerce will establish a Land Remote Sensing Satellite Advisory Committee with representatives of state and local governments, other domestic non-Federal users, and interested domestic private sector groups. Within NOAA, a new major line component, the National Earth Satellite Service, has been proposed to have managerial responsibility for the civil operational land remote sensing satellite program.

User requirements for the fully operational system

User requirements should determine the design of the fully operational land remote sensing satellite system. A survey of governmental and private users indicates a wide range of possible requirements, depending on the type of application being considered, which could justify differing types of satellite systems.

To assist NOAA or an eventual private owner to develop a responsive operational system, a preliminary survey of possible user requirements was made. This survey indicated, for example, that agencies that are interested primarily in renewable resource applications such as agricultural crop assessment want frequent observations, delivery of data within 48 hours in certain circumstances, spectral bands that discriminate between various types of vegetation and resolution higher than that provided by the current Landsat system. State and local governments, requiring data for land use management and protecting environmental quality, request higher resolution over urban and suburban areas and time-series analyses to detect detailed changes. The U.S. mineral extraction and related industries call for stereoscopic[5] capabilities, global coverage, thirty to forty meter resolution and processing of data within a few weeks. Foreign users interests appear to be similar to those of their U.S. counterparts, although area coverage requests obviously differ.

Further analysis and sorting of these requirements with respect to resolution, spectral bands, stereo coverage, frequency of observation and timeliness of product delivery will be necessary as plans are developed for the operational system.

Performance options for the fully operational system

Hypothetical system performance options have been identified to meet some or most of the preliminary user requirements identified above. These options range from designing a system with capabilities similar to the Landsat 3 with MSS only, at an estimated 10-year cost of $1 billion, to building a new system which meets

[5] As used in this context, stereoscopic means two or more images, taken from different angles, to permit inference of the relative height of various topographic features.

most of the currently stated user requirements, including two meter resolution, at an estimated 10-year maximum cost of $10 billion.[6] Stereo coverage can be provided at an additional cost of up to $700 million.

A final decision on the system design to be pursued for the Fully Operational System can be reached only after further analysis of user requirements, technical options, cost comparisons, system financing, and the effect of potential foreign competition.

Revenues, pricing policies and financial assistance

Reliable projections of revenues from sales of standard data products, and from the direct reception fees to be paid by foreign ground station operators cannot be made at this time since the characteristics of the Interim and the Fully Operational Systems, the users' level of demand at various prices, the impact of a market expansion program and the impact of foreign competition are not how known. Tentative projections indicate that this system may not and probably will not be self-financing before the end of the century. Therefore, continued Federal financial contributions to support of the system likely will be necessary for the foreseeable future.

System revenues, generated by the sale of standard data products and foreign ground station access fees, now amount to only $6 million[7] a year.[8] Current fees consist of a nominal $200,000 access fee for foreign ground stations and cost of reproduction charges for standard data products—$200 for a computer compatible tape and between $8 and $50 for various types of Landsat images. The projected costs of the Fully Operational System range from $100 to $400 million a year. To achieve the objectives for the sharing of costs by users, and for the eventual ownership and operation by the private sector, prices must be increased to cover, over time, the capital and operating costs of the system and the data and data products treated in a proprietary manner.

The system's manager could charge three types of fees for data and standard data products.

Basic fee.—A fee paid by each user on each standard data product it purchases from the U.S. system operator. These fees would vary in proportion to the costs incurred in producing that product. They would be paid by users of both real-time and retrospective data. Other factors such as timeliness, the placing of special orders and special handling could be reflected in a surcharge schedule.

Royalty fee.—A fee paid by each U.S. and foreign user and foreign ground station operator on the reproduction or resale of Landsat standard data products.

Direct reception fee.—One or more fees paid by foreign ground station operators receiving data directly from U.S. land remote sensing satellites. Examples of such fees are: (1) an annual access fee like the $200,000 fee per staton per year currently being paid by Landsat station operators, and (2) a transmission fee paid by foreign ground station operators for data transmitted to and received by the foreign ground stations. This latter fee would be based on the amount of data requested.

Upon the completion of pricing studies, a proposed pricing schedule will be developed based on these types of fees, and possibly others, for consideration by the Program Board and the Land Remote Sensing Satellite Advisory Committee.

Since a substantial shortfall is projected between annual revenues and the estimated annual costs of running an operational system of between $100 and $400 million per year, Federal financial assistance likely will be required. In this event, the Federal government could provide various types of capital and operating assistance to a private or government corporation, whichever institutional option is eventally chosen. Such Federal capital assistance could include grants, equity guarantees, and Federal loan and loan guarantees. Federal operating assistance could include Federal support of research and development, purchase guarantees, appropriations, free services and tax incentives.

Whether for the Interim or Fully Operational System, three possible options for Federal agencies to share in the costs of financing the operational land remote sensing system are under consideration:

NOAA could budget for all "core" [9] and special system costs;

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[6] All costs are in fiscal year 1980 dollars.

[7] All revenues are in fiscal year 1980 dollars.

[8] This figure includes $2.7 million from sales, $1.8 million from foreign ground station access fees and $1.3 million attributed to the value of the data distributed without charge to Federal agency users.

[9] The "core" system includes the space and ground segment elements necessary to meet the common needs of the majority of users.

NOAA could budget for "core" system costs and user agencies would budget for special system capabilities; [10]

User agencies could fund individually a predetermined portion of all "core" and special system costs.

A decision on the preferred financing option will weigh, on the one hand, the benefits of having a mechanism that forces agencies to make trade-offs between land remote sensing data and other sources and, on the other hand, the advantages of focusing responsibility for the program and budgeting in one agency.

Institutional approaches to eventual private sector ownership and operation

1. Institutional alternatives.—Several institutional options exist for achieving the goal of eventual ownership and operation by the private sector of our civil land remote sensing satellite activities. The four principal institutional options discussed in the document are:

(1) A private corporation (or consortium) selected competitively to own and operate all or part of the civil operational land remote sensing satellite system and to sell data to Federal agency users under guaranteed purchase contract;

(2) A for-profit private corporation, authorized by Federal legislation, with private equity and privately and publicly appointed Board members;

(3) A wholly-owned government corporation authorized by Federal legislation, with Government equity, reporting to the Secretary of Commerce, with provision for subsequent transformation to a private stock corporation as system revenues warrant; and

(4) Federal agency ownership with private contractor operation, and provision for subsequent transfer to a private sector owner as system revenues warrant.

Options 1 and 2 offer the earliest possibilities of private sector ownership and assumption of risk. Options 3 and 4 delay implementation of private sector ownership until the next decade.

These options will be examined by the Administration over the next several months to evaluate which alternative best serves the Federal, state and local government and private sector interests in having an operational land remote sensing satellite program.

2. Establishment of Federal policy to encourage private sector investment.—Several policies impact the likelihood or willingness of the private sector to own the operational system. For example, under present policy, a system owner has no ownership rights in the Landsat data and standard data products. Without a change in this policy, a private owner would be denied the opportunity for profitability; therefore the Federal government would have to authorize the private sector to own and sell civil operational land remote sensing satellite data and standard data products on terms that eventually permit a reasonable return on investment. Other factors that affect private sector investment are competition from ongoing Federally funded R&D land remote sensing satellite systems and the duration of the Federal government's financial commitment to the land remote sensing satellite program. Conversely, a private system owner should be required to abide by the government policy of widest practical dissemination of data and standard data products on a public nondiscriminatory basis at prices that are consistent for domestic and foreign users.

3. Regulation of private sector operation.—A private owner of the land remote sensing satellite system could enjoy a monopoly. To protect the national interest, the private owner's activities should be regulated to the extent necessary to conform to national space and other domestic and foreign policy objectives. A private or government entity owning the operational system should be required, for example, to comply with international treaties such as the Outer Space Treaty for the conduct of peaceful activities in outer space; continue the widest practical dissemination of data and standard data products on a public nondiscriminatory basis; meet the needs of U.S. government users; and refrain from misuse of insider knowledge obtained from the land remote sensing satellite data.

Market expansion

The system manager should undertake a market expansion program to increase revenues, reduce required Federal financial assistance, and enhance decision-making through the use of land remote sensing satellite data. An important element of this program is assuring continuity of land remote sensing data.

A market expansion program for the operational system can build on the types of training and technology transfer activities now being conducted by NASA and the Department of the Interior. NOAA could arrange for reimbursable training programs, enter into joint applications demonstration projects with users in all sectors,

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[10] Special system capabilities include stereoscopic coverage.

encourage university land remote sensing instructional programs and work with domestic and international assistance agencies to promote new opportunities for American business in the land remote sensing satellite field. As part of its ongoing R&D responsibility, NASA could continue to develop and demonstrate to users new techniques and technologies for using land remote sensing satellite data.

International aspects

The United States should continue to encourage international participation in the U.S. civil operational land remote sensing satellite program by further developing an international community of data users and by continuing discussions with prospective foreign land satellite system operators to explore the prospects for encouraging complementarity and compatibility among future operational land satellite systems.

The United States should ensure that data from the Interim and Fully Operational Systems are made available to foreign users through sales of standard data products on a nondiscriminatory basis. NOAA, working closely with the Department of State and other interested agencies, should take the following actions:

Consider foreign user requirements in planning the Fully Operational System;

Conclude agreements with those foreign agencies wishing to receive data directly from the Interim and Fully Operational Systems;

Establish pricing policies for data sales and direct reception fees that are consistent for domestic and foreign users; and

Continue the Landsat Ground Station Operations Working Group as a forum for the exchange of technical information.

The land remote sensing satellite systems being developed by other countries offer the prospect of both competition and cooperation with the U.S. The competitive challenge to U.S. technological leadership is likely to occur in such areas as the development of multilinear array sensor technology, and sales of ground equipment, services and data products. NOAA, working closely with the Department of State and other interested agencies, should encourage the expansion of world-wide markets for U.S. equipment, services and data products, and pursue prospects for complementarity with foreign satellite operators in order to develop complementary systems characteristics (e.g., orbits, coverage patterns and repeat cycles) and compatible system outputs (e.g., standard data product formats).

Legislation for the operational system

Legal authority in four pricipal areas may be required in order to implement a civil operational land remote sensing satellite system:

1. Authorization for NOAA to develop, own and manage the civil operational land remote sensing satellite system until the responsibility is transferred to a private or other entity;

2. Establishment of the institutional structure, financial assistance and transition to private sector ownership and operation of the U.S. civil land remote sensing satellite system;

3. Establishment of a regulatory system to ensure that a private sector owner's activities are in compliance with U.S. laws, policies and international obligations; and

4. Establishment of proprietary interests in operational land remote sensing data and standard data products.

Summary of issues

The following is a summary of the issues that have to be addressed as the Federal govenment moves toward an operational land remote sensing satellite system:

1. Continuity of Data in the 1980's

a. Operations

Whether to fund, construct and launch additional Landsat D series satellites with tape recorders to provide continuity in the acquisition of data from space until a Fully Operational System can be deployed?

Whether to improve the existing Landsat D ground segment at the Goddard Space Flight Center to provide continuous processing of the acquired data into timely and reliable standard data products?

Whether to transfer responsibility for command and control of the Landsat D space and ground segments from NASA to NOAA?

Whether to transfer responsibility for archiving and disseminating land remote sensing satellite standard data products from the Department of the Interior to NOAA, and whether to co-locate these functions with the satellite command and control and preprocessing facilities at the Goddard Space Flight Center?

b. Management

When to submit to Congress an Administration bill that authorizes NOAA to own and manage an operational land remote sensing satellite system until that system is transferred to another entity?

2. Initiation of a Fully Operational System

How to validate user requirements and their priorities?

When to establish a Fully Operational System utilizing new sensors that meet a broad range of user needs?

3. Pricing Policies and Financial Assistance

How to establish initial price increases for direct reception and for data and standard data products that are consistent for foreign and domestic users, provide adequate advance notice of price increases, and encourage potential users to invest in support equipment and reduce use of competing methods of data collection?

When to implement price increases?

How to fund the capital and operating costs of the Interim and Fully Operational Systems that exceed revenues?

4. Institution for Private Sector Involvement

What, if any, institutional framework for private sector ownership should be submitted to Congress?

What mechanisms for regulating and providing Federal financial assistance to the private sector should be provided in any bill authorizing an institutional framework for private sector involvement?

What policies should control the activities of any private sector owner for ownership of data and standard data products, for conditioning their dissemination on the payment of appropriate fees, for making possible the users' sharing of system costs beyond the costs of reproduction, and for requiring consistent pricing and ensuring nondiscriminatory availability of standard data products.

5. Market Expansion

What market expansion should be authorized for the Federal system manager?

6. International Aspects

How to encourage the growth of worldwide markets for U.S.-produced equipment, services and land remote sensing satellite data and standard data products?

Chapter 1

Introduction

This document discusses the issues and options relating to a national civil operational land remote sensing satellite system pursuant to the President's decision to assign to the National Oceanic and Atomospheric Administration of the Department of Commerce the management responsibility for civil operational land remote sensing satellite activities. The document addresses the issues involved in implementing an operational system, including the physical elements of an operational land remote sensing satellite system, user requirements, system financing including pricing policies for users sharing of costs, Federal management and private sector involvement, market expansion, international aspects, transfers of functions, hardware and personnel and legislative matters.

This chapter discusses land remote sensing from space, reviews the development of applicable civil space policy with respect to land remote sensing from space, and sets forth current Administration direction and the assumptions underlying the document.

A. Land remote sensing from space

The purpose of a land remote sensing satellite system is to provide data and information about the condition of the surface of the Earth's land masses to assist a wide variety of users to make resource-related decisions. Observing instruments are placed aboard a satellite which circles the Earth in an orbit chosen so that the satellite will traverse almost all areas of the Earth on a schedule that facilitates the observations of most interest. The instruments respond to emitted or reflected energy at a number of discrete wavelengths ranging from those of visible light into the infrared region and, potentially, on into the microwave region normally associated with radar.

The character of the data produced and its utility to users are determined by the following key parameters:

Resolution,[1] related to the size of the smallest object that can be delimited accurately from the data;

Spectral bands, related to the portions of the electromagnetic spectrum of energy radiated or reflected by the earth to which the spacecraft sensors are sensitive;

Stereo coverage, related to the availability of data from which the variation in the height of the surface being viewed can be determined;

Frequency of observation, related to the interval between repeat coverage of the same spot on the Earth; and

Timeliness, related to the length of time between the observation itself and the delivery of suitable processed data to users or to the archive.

The signals from the instruments are combined into a data stream which the satellite transmits to one or more receiving stations when it is instructed to do so. The received data stream is recorded and processed to various standard formats. These materials, which are described in greater detail in Chapter II, will be referred to in this document as "standard data products."

Data are either used immediately or stored in an archive for later retrieval and study. Since many processes of long-term interest, such as desertification, land use, or the spread of disease in forested areas, require accurate detection of changes, the ability to retrieve standard data products from the archive for so-called retrospective users significantly enhances the usefulness of the data.

Depending on the information desired by a user, the standard data products may be used directly, or manipulated by computers and interpreted in various ways to produce "value added products". For instance, and image can be constructed using arbitrary colors assigned to ranges of the measured quantities to emphasize differences from one part of the scene to another. The contrast at boundaries within the scene can be enhanced, and the intensities of two wavelength bands at each point of the scene can be compared. This information can be combined with information from other sources, such as topographical surveys or precipitation records. Users often employ professional geologists, agronomists, urban planners, on others as appropriate to interpret these products, providing information that is valuable to those who wish to make decisions involving knowledge about or changes on the surface of the Earth.

The benefits of this information have become evident in decisionmaking on renewable resources (agricultural production and forecasting, and management of rangeland, forests and water resources), non-renewable resources (geologic survey; mineral and petroleum exploration; cartography, coastal oceanography and resource evalution; and demography) and environmental management (urban and regional land use planning; environmental protection; disaster assessment; and coastal engineering). These uses are detailed in Chapter III, User Requirements for the Fully Operational System.

The growing recognition of the value of and need for this data has led to a widespread demand that the Federal government take steps to assure continuity of data.

B. Development of the administration's decision on civil operational remote sensing

The President's decision regarding civil operational remote sensing from space culminated a two-year Administration review of the nation's space policy. In 1977, President Carter directed the National Security Council to lead a review of the existing space policy of the United States and to formulate overall principles to guide United States space activities. This review resulted in a Presidential directive in May 1978, which articulated broad national policies to guide the conduct of United States activities in space and established a Policy Review Committee on Space (PRC (Space)) to provide a forum for discussion of proposed changes to national space policy and for rapid referral of issues to the President. The directive also established that the United States will encourage domestic commercial exploitation of space capabilities under United States government authorization and supervision.

Upon the completion of a four-month interagency analysis by the PRC (Space), in October 1978, a more detailed space policy was formulated setting the direction of U.S. efforts in space over the next decade. Three principal directions for the nation's civil space program were specified: (1) activities will be pursued in space when they can be more efficiently accomplished there; (2) our space policy will reflect a balanced strategy of applications, science and technological development; and, (3) an

[1] The term "resolution," as used in this document, refers to the instantaneous field of view (IFOV).

adequate Federal budget commitment will be made to achieve the objectives of identified space applications.

In October 1978, the decision was also made that the United States would ensure continuity of data from the experimental Landsat program and continue to provide these data to public and private users. In his March 27, 1979, Science and Technology Message, the President reiterated his Administration's commitment to the continuity of land remote sensing satellite data through the 1980's.

In the spring of 1979, Congressional attention also was focused on operational land remote sensing from space. Two major land remote sensing satellite bills were introduced in the 96th Congress: S. 663, introduced by Senator Adlai E. Stevenson, proposed the establishment of an Earth Data and Information Service in NASA, while S. 875, introduced by Senator Harrison Schmitt, proposed the creation of a for-profit Earth Resources Information Corporation. The House Subcommittee on Space Science and Applications of the Committee on Science and Technology, and the Senate Subcommittee on Science, Technology and Space of the Committee on Commerce, Science and Transportation, among others, held hearings. The President's Science Advisor, Dr. Frank Press, stated in Administration testimony that the Administration "is committed to the continuity of remote sensing data for civil application through the 1980s," and further that "the Administration is committed to an operational remote sensing system, although yet undefined." He asked the Congress not to enact a specific bill on operational land remote sensing until the PRC (Space) completed its studies of the system.

The Federal government's policy review of civil operational land remote sensing activities considered in part the satellite system plans of other countries:

France is planning a two satellite land remote sensing system called SPOT, which will begin with a launch in 1984.

Japan is planning a five satellite land and ocean observations program—including a Marine Observations Satellite (MOS–1) in 1985 and a Land Observations Satellite (LOS–1) in 1987.

The European Space Agency (ESA) is planning to launch a Coastal Ocean Monitoring Satellite System (COMSS) in 1986 and a Land Applications Satellite System (LASS) in late 1987 or early 1988.

India launched a rudimentary remote sensing satellite in 1979 and plans one similar to the first in 1982 and a more elaborate mission in the mid-1980s.

The Soviet Union has flown a high resolution land observations camera system on manned and unmanned missions. The Soviets also are testing coarse resolution multispectral scanners on their meteorological satellites.

Some of these systems will incorporate high resolution solid state multilinear array sensors more advanced in terms of resolution than those on Landsat D.

By the summer of 1979, agency task forces had completed their studies and had submitted their recommendations to the PRC (Space). A principal recommendation was to integrate the management of civil operational remote sensing satellite programs within a single agency.

C. Current Presidential direction

President Carter announced the United States policy on civil operational remote sensing in space in November 1979, outlining the policy framework for civil operational land, meteorological and ocean remote sensing satellite programs. NOAA was assigned the management responsibility for civil operational land remote sensing satellite activities in addition to its on-going atmospheric and oceanic responsibilities, and was directed to prepare, in coordination with other appropriate agencies, a time-phased transition plan proposing how to move from the largely experimental Landsat program built by NASA to a fully operational system, with the goal of eventual operation by the private sector.

D. Underlying assumptions

This document has been developed in accordance with the following assumptions, which reflect the policies, established in the President's decision on civil operational land remote sensing and previous space policy announcements, and the prerequisites to their achievement:

The Federal government will ensure continuity of data during the 1980s;

A national civil operational land remote sensing satellite system should ensure continuity of data and the appropriate reliability and timeliness of standard data products;

User requirements, projected levels of demand and the cost of meeting these requirements should determine the design of the operational system;

The Administration's goal is eventual private sector ownership and operation of the operational system, which includes the assumption of financial risk, as well as operational control by the private sector;

Prices for land remote sensing satellite products should be set at levels that ensure maximum recovery of system costs consistent with the public good;

The practice of the widest practical dissemination of Landsat data on a public, nondiscriminatory basis will be continued for the data and standard data products from the Interim and Fully Operational Systems in accordance with prevailing U.S. national policies.

Eventual private sector ownership and operation of the U.S. system will be conducted under Federal government regulation, consistent with U.S. policies and international obligations;

The civil operational land remote sensing satellite program is a national program responsive to Federal interests and U.S. user requirements. Due regard will also be given to foreign user interests and to foreign participation in the U.S. program; and

NOAA will manage the operational system until a new institutional framework is established.

CHAPTER II

PROVIDING CONTINUITY IN THE 1980'S

Because of the long lead time required for budgeting, design, development, construction, launch and check-out, a fully operational satellite and ground system responsive to user requirements could not become operational until 1989 at the earliest. Accordingly, the United States must rely on the existing Landsat D satellite and ground system designs, with additional satellites and ground system improvements as needed and justified programmatically, to meet the objective of assuring data continuity in a reliable and timely manner through the 1980s. The Landsat D satellite design is largely experimental but its capabilities are generally those desired by most users when the TM sensor is operational. It also carries the proven MSS sensor which is operationally reliable, although the current ground system does not meet fully operational standards.

This chapter reviews the existing Landsat 3 system, the currently planned Landsat D system and identifies some system design changes that could be useful for upgrading the Landsat D "Interim Operational System". The management structure and transfers of hardware and personnel necessary to implement this Interim Operational System are also identified.

The chapter assumes certain dates for launching Landsat D and Landsat D', the currently NASA-planned satellite system, but these dates may be changed when a final launch schedule is developed later this year.

A. The existing Landsat system

At the present time, United States land remote sensing satellite data comes from a single experimental satellite, Landsat 3, and its associate ground facilities.[1] Its design and operating characteristics are described in the following paragraphs.

1. Data acquisition.—Landsat 3 was launched in 1978 and currently is operating in an orbit that allows it to acquire data from almost any given spot on the Earth every 18 days. Two instruments are aboard: (a) a Multi-spectral Scanner (MSS), which provides data in four bands of the visible and near-infra-red portions of the spectrum, and (b) two Return Beam Vidicon (RBV) cameras, which essentially provide black and white TV images. The MSS scans a swath 185 km wide and has an instantaneous field view (IFOV) of 80 meters, which for many scenes is approximately equivalent to a photographic resolution of about 160 meters. Each RBV image from Landsat 3 covers an area 90 km on a side (180 km total swath) and has an equivalent IFOV of 40 meters.

Data can be returned to Earth when the satellite is within view of one of the receiving stations—the NASA stations in Alaska, California, and Maryland, and nine foreign owned and operated Landsat ground stations which operate under agreements with NASA. Data acquired while beyond the range of a ground station are stored by a wideband video tape recorder on board the satellite until the satellite is within range of a U.S. station. A control center at the Goddard Space Flight Center (Goddard) monitors and commands the satellite to acquire and transmit data directly to U.S. or foreign ground stations.

The total anticipated life of Landsat 3 is three years, although it may cease to function at an earlier date. No backup satellite for Landsat 3 exists in the current system, so a gap in continuity of MSS coverage may well exist from at least some time in 1981 until Landsat D is launched and begins to function in 1982 at the earliest.

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[1] After ceasing operation in November 1979, Landsat 2 is currently able to provide data within view of the receiving stations within the U.S. and abroad.

2. Preprocessing.—The master recordings (station tapes) at U.S. ground stations of Landsat 3 data are processed at Goddard to segregate data from each of the spectral bands of the MSS and to apply (a) radiometric corrections to account for the difference in response of the detectors in the various spectral bands, and (b) geometric corrections which account for distortions in the satellite viewing process and relate the received data to the exact position on the ground that was observed by the satellite.

The results of this preprocessing are recorded in High Density Digital Tape (HDDT) form, either as fully corrected data, or with the required geometric corrections only noted on the tape. Foreign ground stations perform an equivalent function, although not all of them apply a full set of corrections. The time required for this process currently averages about two weeks at Goddard, although high priority special tasks can be completed within 48 hours.

HDDTs are provided to the Department of the Interior's EROS Data Center in Sioux Falls, South Dakota, and the Department of Agriculture's facility in Houston, Texas.

3. Processing into standard data products.—At the EROS Data Center, the data in HDDT form are put through additional computer processes to convert them into standard data products suitable for sale to public or private sector customers, who in turn may use them in that form or further process them for their own use or for resale to additional customers. Two classes of standard data products are available—film imagery, which is convenient for those accustomed to working with maps and photographs, and computer compatible tapes (CCTs). The tape form is suitable for input to standard computers and lends itself to automated or specialized data handling and analysis. Depending on workload and priority, the time required for the preparation of standard data products averages about 10 days, ranging from a few days to several weeks. The prices charged for these standard data products are set by the cost of producing copies and handling orders. Each of the foreign ground stations is able to generate its own standard products for sale to customers.

4. Special processing.—Some users require extremely rapid processing because of the ephemeral value of the data for such uses as crop forecasting and water quality assessment. Special processing to enhance certain features or to meet R&D needs, such as the development of new interpretation techniques, also is required by users. Some users, such as the mineral extractive industry, arrange for their own special processing to obtain information suited for their particular requirements.

5. Archiving.—The bulk of U.S. Landsat data is archived at Goddard and the EROS Data Center. (Master tapes are at Goddard; processed products are at the Center.) In addition to the physical safekeeping of the records in an economical form, the archival function includes maintaining an inventory, a browse system for searching the records, and a retrieval system that permits rapid and efficient response to orders for retrospective data.

The NASA agreements with foreign ground station operators call for such stations to provide the EROS Data Center with a listing, but not copies, of all their accessions from the Landsat program. This approach reduces the cost of operating the archive at the EROS Data Center by avoiding the cost of generating a duplicate archive for the foreign holdings.

In addition to the central products archive at the EROS Data Center, separate partial collections are maintained by major users of Landsat data for their own purposes.

6. Training and applications development.—Since the application of Landsat observations to resource management is a relatively new field, training is an important part of the current program. Training breaks into two categories: (a) maintenance and operation of station and processing equipment, and (b) training in the interpretation and use of Landsat data.

Training in maintenance and operation is done by the equipment manufacturers or on the job. Training in interpretation and use of the data is available through a number of universities and private organizations, but the major organized effort is run by the EROS Data Center, which has developed curriculum material and acquired the necessary facilities. The EROS Data Center is not able to accommodate all of the requests for training it receives. About 90% of its curent training is in support of Department of the Interior (DOI) needs, and the balance is devoted to students sponsored by other U.S. government agencies or foreign governments. Foreign students often are sponsored by the Agency for International Development (AID), either at the EROS Data Center or in training programs abroad, which have been conducted to foster the beneficial use of Landsat data.

The development of new applications of Landsat data and new techniques of interpretation goes hand-in-hand with training professionals in the new methods. NASA, through its technique development and transfer programs, works directly

with potential new users partly to develop and test new application techniques and partly to learn at first hand the users' practical needs. Similarly, DOI has set up arrangements for joint application programs with users. Some private sector firms work directly with customers.

B. The currently planned Landsat D system

The Landsat D system was designed by NASA in large part as an experimental system. The major objectives of the Landsat D program are to continue the availability of MSS data after the demise of Landsat 3, to assess the capabilities of a new sensor, the Thematic Mapper (TM), and to provide a transition from MSS to TM data. The Landsat D system as currently designed has the following characteristics:

1. Data acquisition.—The Landsat D series of satellites is designed to carry a TM in addition to an MSS. The TM will have seven spectral bands, including three in the infrared region, and an instantaneous field of view (IFOV) of 30 meters for all but the thermal infrared band. Each satellite's sun-synchronous orbit will have a repeat cycle of 16 days. Data will be returned to ground stations in two ways: (a) directly to foreign ground stations, at S-band for those who wish to continue to receive only MSS data without modification to their equipment, and at X-band for those who wish to receive a combination signal of MSS and TM data; and (b) indirectly through the Tracking and Data Relay Satellite system (TDRSS) to the single U.S. TDRSS ground station at White Sands, New Mexico.

Two satellites, Landsat D and D', are currently under construction. Each satellite is estimated to have a life expectancy of about three years.

2. Preprocessing.—Preprocessing will take place at the Landsat D ground system facility at Goddard. The production objective is a daily output in HDDT form of 200 MSS scenes per day beginning no earlier than 1983, and up to 50 TM scenes per day no earlier than 1985. Because of the additional spectral bands and the higher resolution of the TM, and the resultant substantially higher complexity and volume of data, TM preprocessing, although similar in nature, is substantially more complex than MSS preprocessing. Current system design provides for serial processing with 85 percent confidence that, averaged over a ten day period, all data will be processed and made available from the ground station within 48 hours of receipt. A Landsat Assesssment system, an R&D facility for investigation and development of new earth resources management techniques using data from the TM sensor, is planned by NASA in conjunction with the Landsat D ground facility.

3. Processing and dissemination of standard products.—Standard data products will include film imagery, digital for direct transmision where required for immediate use, and digital data on magnetic tape. The data will be radiometrically corrected and will include geometric referencing information (i.e., HDT-A form). In addition, a limited variety of standard mapping projections will be available in both digital and film form.

The EROS Data Center will achieve and disseminate Landsat standard data products to domestic and foreign users from its facility in Sioux Falls, South Dakota.

C. The interim operational system

1. System design.—From the point of view of the users, "data continuity" means that data will be collected continuously and made available in a timely manner with a reasonable degree of reliability. From a technical standpoint, the following performance objectives have been identified as applicable to a high quality operational land remote sensing satellite system:

Sensors designed to generate data meeting a broad range of user requirements at a reasonable price;

Assured continuity of satellite coverage without break, with one backup satellite in orbit at all times and another on the ground;

95 percent confidence that, averaged over a two-day period, all data will be processed and made available from the ground station within 48 hours of receipt; and

Ability to identify and process certain data out of order to meet urgent user needs.

While sensors designed to generate data meeting a broad range of user requirements cannot be provided until the late 1980s, the Landsat D sensors will be able to accommodate many user needs. Some system design changes could be made in the currently planned Landsat D system that would move towards meeting these performance objectives during the Interim Operational System. Such system design changes have to be justified on how essential they are to the users and how they will be financed.

a. Data Acquisition

In response to the commitment to continuity of land remote sensing satellite data through the 1980s, NASA and NOAA are reviewing the Landsat D series launch schedule in light of two interrelated concerns:

No backup to Landsat 3 exists other than Landsat D which could lead to a gap in coverage between the demise of Landsat 3 and the launch of Landsat D; and

One or more additional satellites may have to be scheduled to follow Landsat D and D', to ensure coverage following the end of the useful life of Landsat D' and before the Fully Operational System is established.

There is a strong likelihood that there will be some data coverage gap between Landsat 3 and D. NASA, however, is currently reviewing possible alternatives for launching Landsat D. One alternative is the launch of Landsat D without the TMM in 1982. In that case, Landsat D' with the TM, which will be available for launch in 1983, would be launched in late 1983 or early 1984.[2] To maintain continuity between Landsat D' and the eventual Fully Operational System may necessitate procurement of follow-on spacecraft.

Another change which could be made to the Interim Operational System is the placement of tape recorders on Landsat D' and subsequent satellites to ensure full collection of MSS data when the TKRSS system is unavailable due to schedule conflicts and to provide MSS data from the so-called "zone of exclusion," the area over the Indian sub-continent and south-central USSR where direct satellite transmission via the TDRSS is physically impossible. However, some of the data might be obtained through ground stations on an as needed basis.

b. Preprocessing

Improvements to the Landsat D ground system facility at Goddard could also be made at some time in the interim phase if necessary to minimize the risk of losing some data or having an excessively long delay in processing some data. Some possible ground system changes are discussed below. To increase reliability, points in the current system where failure of a single component could completely halt the processing of data could be eliminated. Equipment also could be added to provide out-of-order processing for data on significant events such as flooding and crop freezes. Initiation of these improvements could move the system towards the high quality operational performance standards.

MSS data and standard data products will be available on an initial operational basis no earlier than 1983. Following the launch of Landsat D', no later than early 1984, and assuming techniques for producing standard data products from TM are developed, TM data can be produced on an initial operational basis by 1985.

c. The "Core" System

The Landsat D system, with any improvements suggested above, will be considered the "core" Interim Operational System for purposes of the document. Additional capabilities, such as stereoscopic capability and continuous dedicated dual coverage, will not be added to the Interim Operational System unless users are found who are willing to pay the initial capital and subsequent operating costs.

2. Management arrangements.—

a. NOAA's Management Functions

The following transfers of operational responsibility will allow NOAA to operate the Landsat D System as an Interim Operational System:

NOAA will assume responsibility from NASA in fiscal year 1983 for the command and control of the system and will begin providing MSS data on an operational basis after the successful launch and check-out of Landsat D and the MSS ground system, and after NASA has demonstrated that the System is operational. NOAA will assume responsibility for TM data when that portion of the System reaches an initial operational level of performance;

NOAA will assume responsibility from NASA and the EROS Data Center in fiscal year 1983–84 for the generation and dissemination of data and standard data products. Assuming this is cost-effective, a new facility would be co-located with the Landsat D preprocessing facility at Goddard and would be the sole sales outlet in the United States of data and standard products from the Interim Operational System; and

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[2] The administration is also considering other alternatives such as delaying the launch of Landsat D until 1983 when the TM sensor will be ready.

NOAA will take title to Landsat archival material at Goddard and the EROS Data Center in fiscal year 1984 and will be responsible for archival functions for the Interim Operational System.

Plans for the transfer of functions, hardware and personnel are described in Section D of this chapter.

In addition to managing the technical system during the interim operational phase, NOAA should carry out the following functions in order to assure full implementation of an operational system:

Manage all Federal funds required for the operational system. Except as necessary for its market expansion programs and NOAA's other mission needs, NOAA will not fund the purchase of data and standard data products by users, the provision of special services uniquely required by user agencies, the preparation of value-added products, or the R&D and any prototype procurements required for the operational systems (the latter being funded by NASA);

Evaluate the data requirements of users and ensure that the operational system meets their needs to the maximum extent possible, given user willingness to reimburse for services and budgetary contraints;

Establish and operate a satellite and ground processing tasking system that responds to programmatically justified user priorities;

Implement the President's goal with respect to the eventual ownership by the private sector of the land remote sensing satellite system by pursuing appropriate pricing and market expansion efforts, and the establishment of a satisfactory institutional framework based on the private sector's willingness to invest and share in the risk;

Establish policies for the sale of Landsat data and standard data products to users;

Arrange for direct reception at appropriate cost of Landsat data by foreign ground stations, pursue complementarity and compatibility among national operational land remote sensing satellite systems, and represent U.S. operational land remote sensing satellite interests with other countries and international organizations;

Seek such legislation, Executive Orders, and Presidential directives as are necessary for the operation of the U.S. operational land remote sensing satellite system and for the adoption and enforcement of appropriate regulations.

NOAA proposes to assign the responsibility for managing the operational land remote sensing program to a new National Earth Satellite Service (NESS). When approved, NESS would be a major line component within NOAA, headed by an Assistant Administrator for Satellites who reports directly to NOAA's Administrator. NESS will consist of NOAA's programs under the former National Environmental Satellite Service, augmented to handle NOAA's new management and policy responsibilities and the additional technical activities. NESS will be organized to ensure adequate attention to policy formulation, regulation, relations with users and private industry, and international activities related to land remote sensing. NESS will continue to manage the Nation's civil operational meteorological satellite system and NOAA's responsibilities related to the proposed National Oceanic Satellite System (NOSS). NOAA's Environmental Data and Information Service will manage the Landsat archiving function and will disseminate Landsat standard data products to users of retrospective data.

b. Interagency Coordination

Pursuant to the President's decision, the Commerce Department will, in fiscal year 1981, establish and chair an Assistant Secretary level Program Board for continuing federal coordination and to consider issues related to regulation of private sector involvement. The Board will be composed of representatives from the Departments of Defense, the Interior, Agriculture, Energy, State and Commerce, the National Aeronautics and Space Administration, the Environmental Protection Agency, the Agency for International Development, the U.S. Army Corps of Engineers-Civil Works, the Director of Central Intelligence and the Executive Office of the President.

The Program Board will serve as a mechanism for continuing Federal coordination and regulation on such matters as:

Policy issues related to the civil land remote sensing statellite program;
NOAA's management of the civil land remote sensing satellite program;
International negotiations;
Priorities among the data requirements of the Federal and other users;
A satellite and ground processing tasking system;
Data and pricing policies;
Proposals for private sector involvement;
Private sector regulation;

Federal budget requests;
Relationships with other Federal data sources; and
Necessary research and development.

If NOAA's management decisions are at variance with the Program Board's policy recommendations, the Program Board or any one of its members may refer such issues to the PRC (Space) for consideration and action.

The role of the Program Board will be re-evaluated by the PRC (Space) if an entity other than NOAA assumes responsibility for the ownership and operation of the U.S. civil land remote sensing satellite program.

c. Non-Federal Participation

The Commerce Department plans, in fiscal year 1981, to establish a Land Remote Sensing Satellite Advisory Committee consisting of fifteen representatives from the interested domestic non-Federal communities, including State and local government, end users, organizations that use Landsat data to supply information products, service organizations, and potential commercial system developers and operators. These representatives will be selected by the Secretary of Commerce and will serve three year staggered terms. The Chairman and Vice-Chairman will be designated by the Secretary of Commerce. The Chairman will be asked to attend Program Board meetings as necessary. NOAA/NESS will provide staff support to the Advisory Committee.

The Land Remote Sensing Satellite Advisory Committee will advise NOAA with respect to the interests of the domestic non-Federal user communities in the following areas:

Management of the civil land remote sensing satellite program;
Priorities among the data requirements of non-Federal users;
Policy issues related to the civil land remote sensing satellite program; and
Proposals for private sector involvement.

The role of the Advisory Committee will be re-evaluated if an entity other than NOAA assumes responsibility for the ownership and operation of the U.S. civil land remote sensing satellite program.

In addition to creating the Advisory Committee, NOAA will continue to work closely with all users on their data requirements and on approaches to private sector involvement in the operation of the system. NESS will establish an office to serve as a focal point for liaison with the Landsat user community, technical societies and special interest groups, and with those companies concerned with private sector involvement.

D. Transfers of functions, hardware, and personnel

Implementation of the Interim Operational System will require transfers of the function of archiving and dissemination of standard data products from the EROS Data Center (EDC) in the Department of the Interior and of hardware and personnel from the National Aeronautics and Space Administration (NASA). The necessary transfers are set forth below. Interior and NASA have indicated their concurrence in these transfers.

1. The EROS Data Center.—The only functions at the EROS Data Center within NOAA's new management responsibility for the U.S. civil operational land remote sensing satellite program are the national archiving of Landsat data, and the servicing of users who draw upon this archive. The many other functions performed at EDC, such as the archiving of Interior's aircraft data, serving users who draw upon this archive, as well as research related to Landsat applications and the conduct of training programs in the use of Landsat data, primarily service Interior in the performance of its missions.

Interior and Commerce have agreed that it is probably in the best interest of the programs of both agencies that the national Landsat archiving and retrospective user service functions be co-located with the preprocessing facility for the Landsat program at the Goodard Space Flight Center. Such a co-location should ensure more efficient and reliable operation under one contractor, enable cost savings to be realized in the modification of the MSS ground system to handle TM data, and facilitate any future integration of Landsat data processing with the processing of data from the meteorological and ocean remote sensing satellite systems.

The transfer of these functions to NOAA will occur by fiscal year 1984 when operational use of Landsat D MSS data has begun and management responsibility has been transferred to NOAA. These transfers will result in the loss of revenues to Interior from the sale of Landsat standard data products—currently $2.7 million. Future revenues will be collected by NOAA.

2. NASA transfers.—NASA and Commerce have agreed on a phased transition of operational responsibility from NASA to NOAA with respect to the Landsat D

program beginning in 1983.[3] Ownership of the operational Landsat D hardware will transfer to NOAA along with the transfer of operational responsibility. Major steps in this transition are set forth below:

Fiscal year 1983: Data processing responsibility for MSS data transferred after NASA has demonstrated that the system is operational;

Fiscal year 1983: Command and control responsibility for Landsat D transferred at the time data processing responsibility for MSS data is transferred;

Fiscal year 1984: NOAA will work with NASA to archive and disseminate TM data during the initial production phase from early 1984 until operational status is achieved.

Specifically, NASA will provide NOAA with space in Building 28 and elsewhere at the Goddard Space Flight Center to house the command and control, preprocessing, processing, archiving and dissemination functions for the Landsat D program. NOAA will reimburse the Goddard Space Flight Center for operational support costs and maintenance. No building transfers will be required.

NASA uses contract personnel for most day-to-day Landsat operations and control. Since NOAA plans to contract out the operation and maintenance of the Landsat D facilities, existing NASA contract tasks will be phased over to NOAA during the transition period and appropriate budget adjustments between the two agencies will be made.

When Landsat D MSS operations are transferred to NOAA, NASA will transfer to NOAA available positions from the Goddard Space Flight Center and from its Office of Space and Terrestrial Applications, which provide current civil service support, for the management of operational aspects of the Landsat program, the tasking of Landsat satellites and the interface between operational users and the Landsat program.

Staff support of these functions is also provided by NASA Headquarters staff offices, including the Office of the Comptroller, the Office of General Counsel, and the International Affairs Division. As needed, civil service positions will be transferred from the International Affairs Division in connection with functions related to the Landsat Ground Station Operations Working Group and the negotiation of Memoranda of Understanding with foreign station operators, which will be assumed by NOAA in Fiscal year 1983.

Chapter III

User Requirements for the Fully Operational System

The earliest opportunity to achieve significant improvements in performance characteristics beyond the Landsat D system would be 1989, since the sensor research and development activities necessary to support an improved system cannot be completed before that time at the earliest. To determine the optimum design of such an improved system cannot be completed before that time at the earliest. To determine the optimum design of such an improved system, an evaluation of anticipated user requirements for data and standard data products from the Fully Operational System is required.

This chapter reviews briefly the methodology used in projecting user requirements, the current uses of land remote sensing satellite data, and the preliminary estimates of technical performance characteristics to meet user needs at varying levels of satisfaction.

A. Methodology used in projecting user requirements

Projecting the types and quantities of data that users will desire a decade from now from a largely unknown, highly sophisticated, multiple use system is an extremely risky effort. Among the factors unhibiting meaningful projections are:

For those users requiring reliable and timely standard data products, the current absence of such products with which users can experiment to determine the products' usefulness;

The rapid changes in computer technology—both increased capacity and reduced cost—that may make currently impracticable types of data analysis routine by the end of this century;

The importance of interactive use of these products with other sources and types of information, such as weather, seismic, geomagnetic, and demographic data, which makes the value of these products dependent on changes in the availability and cost of other products;

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[3] These dates are subject to refinement when the final launch schedule for Landsat D and D' is determined.

The continuing identification of new techniques for using the products, as research on the interpretation of new types of land remote sensing satellite data progresses;

The tendency of users to express a preference for currently available types of data or to make self-limiting assumptions about available technology when defining their needs;

The converse tendency of sophisticated users to want the very best product, especially when price differentials and their own levels of use cannot readily be predicted, because the very best product will then be available if needed; and

The tendency of users to define product requirements in terms of their current missions and objectives, which may undergo significant alteration by the end of the century.

Several of these factors will be affected significantly during the 1980s by the experience derived from the Interim Operational System described in Chapter II, and by the scope and character of a domestic and foreign market expansion program further described in Chapter VII.

In analyzing user needs, the Commerce Department drew upon the existing body of literature—prior space policy studies; internal studies within the major federal user agencies; studies by associations of state and local government users; statements by an association of users in the minerals extraction industry; NASA studies related to the Landsat program; and the limited number of assessments by private companies of the future requirements of U.S. industry, foreign industry and foreign governments.

In addition, NOAA requested the major user groups to evaluate the initial assessment of user requirements that was developed from the existing literature. Domestic non-federal users were asked to contribute by reviewing the initial assessment at five regional user workshops, commenting particularly on those system performance characteristics which were of importance to their applications.

The material in this chapter includes changes suggested by the major user groups. It represents the most comprehensive survey of user requirements conducted to date.

The process of collecting and assessing user requirements is by no means complete, however. The initial assessment was not tied to any information about prospective costs of standard data products, which will be a key determinant of actual user demand. In addition, no assessment has been made of the number of images or computer compatible tapes or other standard data products that could be sold as a function of price. Such a market survey would not yield limited meaningful results until the options for a Fully Operational System are clearly defined and a range of probable prices for particular types of data can be offered for evaluation by users.

Assessment of user requirements must, therefore, be a continuing, interactive, process involving the evaluation of needs and relative benefits as a function of system performance and cost. Mechanisms for achieving this ongoing evaluation will be available to federal users through the Program Board described in Chapter II, and to the relevant professional societies, industry associations, associations of state and local governments and representative commercial users through the Land Remote Sensing Satellite Advisory Committee, also described in Chapter II.

B. Current and projected uses of Landsat data

This section review the currently expressed requirements of users in terms of the types of users to which Landsat data are now being applied. As the section will indicate, users have widely varying needs. These needs have been analyzed to identify probable performance characteristics that the Fully Operational System could possess to serve the stated users' purposes. Table III-1 summarizes these needs for the various types of domestic users. No prioritization of these needs was attempted. Decisions of this type must await the budget review process and subsequent actions. Likewise, no assessment has been made as to how essential these characteristics are in terms of users' stated purposes and their willingness to pay higher costs.

1. Renewable resource applications.—The feasibility of using remotely sensed data as a component of a global agriculture monitoring system was indicated in the Large Area Crop Inventory Experiment (LACIE) from 1974 to 1977. This program drew upon Landsat data and upon weather information to provide timely, objective estimates of wheat production in several areas of the world. It substantially transformed the state of the art in machine processing of Landsat data.

The LACIE results led to the initiation of the Agricultural and Resources Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS), a six-year research and demonstration program involving NOAA, USDA, NASA, DOE, and AID. Its goal are to develop and evaluate procedures and methods to provide routine early warning of changes in crop conditions; more objective and reliable production fore-

casts of wheat, barley, corn, soybeans and rice; and better inventories of U.S. land cover, water, forests, rangeland, and other renewable resources.

Landsat data also appear useful in inventorying and managing rangelands and in forest management, helping reduce forest management costs through improved sampling procedures for estimating volumes of timber, monitoring the progress of "clear-cutting" operations, and mapping forest fire burn areas to guide replanting efforts.

Cooperative demonstrative programs with a major wood products company with large holdings of forest areas, with an industry asociation concerned with global trading in cotton, and other commercial organizations have encouraged these industrial participants to plan for or implement operational programs using Landsat data. Value added service companies have created a small but growing service to suppy information to commercial users concerned with commodity trading.

2. Nonrenewable resource applications.—Landsat data, combined with other data sources such as aircraft magnetic and gravity surveys, are widely used by the minerals industry in its search for and exploitation of new sources of oil, gas, and other minerals.

Landsat data are being used to create geological maps for the siting of major construction projects, including railroads, highways, dams, and power plants. Landsat images have shown many fault lines not detected using conventional aircraft or ground data, which are important in assessing nuclear power plant sites and for earthquake prediction research.

Landsat date are particularly useful in detecting features that change over a short period of time, such as a stream course following a major flood, or a coastline after a major storm. Landsat images were used, for example, by scientists in Bangladesh to measure the accretion of new lands to islands in the Bay of Bengal, opening the way for a tree-planting program to stabilize the land and expand agricultural capacity.

3. Planning and environmental management applications.—Landsat imagery has proven useful for a variety of applications related to regional planning, such as monitoring the conversion of agricultural land to housing or the pace at which forest land is being depleted. Because of its limited resolution, MSS data have served only to pinpoint areas of rapid change on which planners can focus more intensive study. Higher resolution space-derived data would reduce the need for more expensive follow-up data collection programs.

The ability to recognize discontinuities in the color of inland or coastal waters using Landsat data has proven of value in identifying erosion, river sediment loads, oil slicks and oil see page in coastal areas, effluents carrying industrial or municipal wastes, siltation and wetlands conditions. Navigation channels and inlets can be watched to detect changes in depth which may endanger shipping and boating.

Landsat data already have proven to be a useful tool for acquiring valuable hydrologic information for water resource management, such as identifying water bodies larger than 10 acres, locating likely ground water supplies, estimating snow cover and monitoring stream networks, all of which contribute to water supply management and flood avoidance studies.

Landsat data have been used for cartography, greatly exceeding original expectations for the many areas of the world where adequate topographic maps do not exist, as well as for small-scale mapping in the United States. The satellite information can be turned into a finished map product very promptly at a much lower processing cost than aircraft data.

C. Data specifications of major users

A better sense of the nature and scope of the projected user demand for land remote sensing satellite data emerges from considering user specifications in terms of institutional categories as well as by types of use. This section presents user needs in that framework.

1. Federal agencies.—The largest U.S. user group consists of the Federal agencies. In 1979, the U.S. Department of Agriculture, the Department of the Interior, the Civil Works Program of the U.S. Army Corps of Engineers, NASA (which provided data to industry, state and local governments, and the academic community for cooperative research and demonstration programs), and other Federal agencies used approximately 50 percent of the data provided by U.S. data distribution centers. While use by all groups is expected to expand during the coming decades, the Federal government probably will continue to dominate the market.

Performance characteristics related to the analysis of renewable resources dominate the current projected needs of Federal agencies, including

Frequent repeat observations—especially during critical times in the growing season;

Delivery of data within 48 hours to monitor global crop conditions in certain circumstances;

Spectral bands that are most useful in discriminating between various types of vegetation, such as wheat and other small grains;

Higher resolution to facilitate analysis of timber, rangeland, and small fields; and

Capacity to collect and process large volumes of data to deal with global conditions.

Federal programs related to geology, lithology, land forms and related activities of the Department of the Interior, the Corps of Engineers, and other agencies need data from the visible, the near, shortwave and thermal infrared, and the radar portions of the spectrum. These system performance characteristics are similar to those for private industry discussed below, but most Federal users need non-renewable resources data only from the United States. Monthly to seasonal frequency and data delivery within a month are adequate in most cases.

Some Federal data requirements related to planning and environmental management support major program objectives, such as water quality assessment, wildlife habitat monitoring, coastal zone activities, beach erosion assessment and flood control. The system performance characteristics of the Landsat MSS, combined with data from the blue-green band of the TM at resolutions higher than the TM's 30 meters, would meet the needs of these users. The volume of data taken uniquely for these purposes would be relatively low, and all of it would be taken over the United States and its territories. A data set taken monthly to seasonally and delivered within one or two weeks would meet most requirements.

The Federal government also has a substantial interest in the availability of land remote sensing satellite data to support its economic development activities and aid programs abroad through the Agency for International Development and other Federal and international agencies. These activities are described in greater detail in Chapter VIII. The data needs are described below.

Preliminary Federal agency needs are summarized in Table III-2. These projections of data needs are tentative until further analyses are completed of their programmatic value.

2. State and local governments.—Organizations in thirty-five states have used Landsat data—some as part of demonstration programs, some as parts of established programs.

According to the National Governors Association, use by state and local governments is expected to expand as the technology to extract information is further transferred to local government organizations and to the value added service industry, which can provide derived products to meet governmental needs.

Renewable resource applications establish data specifications for resolution, spectral bands and data delivery that are similar to those of the Federal government. Only domestic data are required. For non-renewable resource applications, system performance characteristics that meet the requirements of Federal agencies and domestic industries also would satisfy those of state and local governments.

Some state and local government requirements for data needed for land use management and environmental quality protection are more stringent. They call for higher resolution over urban and suburban areas than over rural areas; as well as time-series analyses to detect detailed changes. The relative costs of acquiring these data by satellite or aircraft need to be considered. Other planning and environmental management requirements are similar to those of the Federal agencies.

Table III-3 summarizes the possible requirements of state and local governments.

3. U.S. commercial organizations.—Those companies involved in the search for and extraction of oil and hard minerals are currently the largest commercial users of Landsat data. Commercial use of the data for crop monitoring and forest management is in the early stages, and projections are that this demand will grow substantially as the interpretation is transferred to the commercial sector and data continuity is assured. Another new market that has begun to develop is the consulting and design engineering community. This value added service industry is composed of those firms that have established the capability to extract information from Landsat data to meet the requirements of their customers. It is expected to grow rapidly in the future.

Spectral specifications for both industry and government use are the same as those specified for the TM, with data from the infrared and thermal portions of the spectrum being more important than for other applications. Industrial users who need global data place a relatively higher priority on the acquisition of stereoscopic data over those portions of the globe that have inadequate topographic information. Good quality data taken seasonally and made available within a few weeks would meet most needs, although delivery within a day or two of acquisition is important

to those firms that are sending out field parties. Required data volumes are much higher because industry is involved in the global search for new mineral sources.

Renewable resource applications by industry demand no operational system performance characteristics beyond those that would be required by Federal users. No unique commercial requirements for data related to planning and environmental management have been identified. A system that met the stated needs of Federal, state and local government users would be adequate for commercial purposes.

Possible requirements of U.S. private industry are summarized in Table III-4.

4. Foreign users.—Thirty-six percent of the revenue from sales of standard data products at the EROS Data Center came from users with foreign addresses. Sales to additional users abroad have been made by countries that have established ground receiving stations. Such purchases may increase as analytical capabilities become more widely developed. NOAA will assist in organizing and will participate in regional meetings with foreign users in order to be better apprised of the interests and data needs of users in other countries.

Commercial and governmental users in other countries have identified requirements for resolution, spectral bands, repeat observations and data delivery that are substantially similar to those of their counterpart organizations in the United States. At lower resolutions, such as 80 meters, approximately the same volumes of data would be acquired and processed to meet the needs of domestic and foreign users because of domestic requirements for foreign data. As resolution increases to 30 meters or higher, the demand by foreign users is expected to grow more rapidly.

TABLE III-1
SUMMARY OF POSSIBLE REQUIREMENTS
FOR LAND REMOTE SENSING (All Domestic Users)
(Based on Available Data as of April 1, 1980)

Performance Parameter	PROGRAMMATIC CATEGORY GROUPS		
	Renewable Resources	Non Renewable Resources	Planning/Environmental Management
Spatial Resolution (Meters)	Range 2 80 m; 10 30 m Most Useful 2 30 m meets 90% of Requirements[1/] 10 30 m meets 81% of Requirements 15 30 m meets 80% of Requirements[5/] 30 80 m meets 10% of Requirements	Range 3 100 m; 30 80 m Most Useful 3 30 m meets 30% of Requirements 10 30 m meets 28% of Requirements 15 30 m meets 26% of Requirements[5/] 30 80 m meets 70% of Requirements	10 80 m; 10 30 m Most Useful 10 30 m meets 60% of Requirements 15 30 m meets 50% of Requirements[4/] 30 80 m meets 40% of Requirements
Spectral Bands	MSS/TM Type Plus Microwave	MSS/TM Type Plus Microwave	MSS/TM Type
Timeliness (Observation to User, Days)	2 Days – 15%[2/3/] 2 7 Days – 50% 7 30 Days – 35%	30 Days 100%	2 7 Days – 40%[2/3/] 7 30 Days – 60%
Repeat Coverage Cycle (Days)	5 7 Days – During Growing Season Seasonal at Other Times[4/]	Seasonal	Seasonal
Area Coverage	Global Capability	Global Capability	Domestic Capability
Stereo Coverage	Needed for 20% of the Requirements	Needed for 35% of the Requirements	Needed for 15% of the Requirements
Estimated Annual Data Volume (185 KM Square Scenes)	22,000 to 29,000	15,000 to 19,000	4,000 to 6,500

1/ Percentage determined largely from expressed agricultural requirements. Other applications, as they become known, would cause some limited increase.

2/ Very rapid data delivery is required for observations over areas affected by major hurricanes, floods, earthquakes, pollution events, and similar episodes.

3/ Most critical requirements are for data which is used by the government or industry on regional or global crop condition assessment and production forecasting.

4/ Estimate by NOAA based on incomplete information in user requirements data base. Cost and complexity for adding a single channel at 10 m instead of 15 m is under examination.

TABLE III-2
SUMMARY OF POSSIBLE FEDERAL
REQUIREMENTS FOR LAND REMOTE SENSING

Performance Parameters	Percent of Requirements Satisfied by Specified System Parameter	
	Optimum Value	Minimum Acceptable Value
Spatial Resolution (Meters)	2.3 m – 37% 10 m – 33% 30 m – 28% 80 m – 2%	10 m – 25% 30 m – 20% 80 m – 55%
Spectral Bands	TM Type – 100%[1]	MSS Type – 100%
Timeliness (Observation to Users; Days)	1 Day or Less – 14%[2] 2 Days – 28%[2] 3 to 14 Days – 45% More Than 14 Days – 13%	1 Day or Less – 2%[2] 2 Days – 16%[2] 3 – 14 Days – 42% More Than 14 Days – 40%
Repeat Coverage Cycle (Days)	Complete Seasonal Coverage for Non-Renewable Resources, 4 to 8 Days for Other Users	Same as Optimum Requirements
Area Coverage	Global Capability	Global Capability
Stereo Coverage	Needed for 20% of Requirements	Needed for 20% or Requirements
Estimated Data Volume (185 KM Square Scenes)	Up to 50,000	Up to 30,000

[1] MSS Band 7 (0.8–1.1 μm) is used in analyses and has been found valuable in assessing crop vigor. The TM does not observe in the interval 0.9–1.1 μm. If the number and criticality of such uses is high, spectral bands will be adjusted.

[2] Very rapid data delivery is required for observations over areas affected by major hurricanes, floods, earthquakes, pollution events, and similar episodes.

[3] Most critical requirements are for data which is used by the government or industry in regional or global crop condition assessment and production forecasting.

TABLE III-3
SUMMARY OF POSSIBLE STATE/LOCAL GOVERNMENT
REQUIREMENTS FOR LAND REMOTE SENSING
(Based on Available Data as of April 1, 1980)

Performance Parameters	Percent of Requirements Specifying Value	
	Optimum Value	Minimum Acceptable Value
Spatial Resolution (Meters)	10-30 m – 42% 30-50 m – 50% 80 m – 8%	30 m – 6% 80 m – 94%
Spectral Bands	TM TYPE – 100%[1]	MSS Type – 100%
Timeliness (Observation to Users; Days)	4 Days – 46%[2] 14 Days – 54%	4 Days – 33%[2] 21 Days – 42% 60 Days – 25%
Repeat Coverage Cycle (Days)	7 – 9 Days[3]	Seasonal
Area Coverage	Domestic U.S.	Domestic U.S.
Stereo Coverage	Needed By 13%	None Specified
Estimated Annual Data Volume (185 KM Square Scenes)	2000 – 4000	

1/ MSS Band 7 (0.8 – 1.1 μm) is used in analyses and is considered valuable in assessing crop vigor. The TM does not observe in the interval 0.9 – 1.1 μm. If the number and criticality of such uses is high, spectral bands will be adjusted.

2/ Very rapid data delivery is required for observations over areas affected by major hurricanes, floods, earthquakes, pollution events, and similar episodes.

3/ Most critical requirements are for data which is used by the government or industry in regional or global crop condition assessment and production forecasting.

TABLE III-4
SUMMARY OF POSSIBLE U.S. PRIVATE REQUIREMENTS
(Based on Available Data as of April 1, 1980)

Performance Parameter	Domestic U.S. Coverage		Foreign Coverage	
	Optimum Values	Minimum Acceptable	Optimum Values	Minimum Acceptable
Spatial Resolution (Meters)	10 m – 64% 30 m – 36%	30 m – 71% 80 m – 29%	10 m – 71% 30 m – 29%	30 m 80% 80 m 14%
Spectral Bands	TM TYPE – 86%[1] Radar – 14%	MSS Type – 100%	TM Type – 100%[1]	MSS Type 100%
Timeliness, Days (Observation to User)	2 Days – 14%[2][3] 14 Days – 86%	14 Days – 72% 90 Days – 18%	2 Days – 17%[2][3] 14 Days – 86%	14 Days 14% 90 Days 80%
Repeat Coverage Cycle (Days)	Complete Seasonal Coverage for Non-Renewable Resources; 7-9 Days for Other Applications[3]		Same as for Domestic Coverage	
Area Coverage	Entire United States		Global Land Area Capability	
Stereo Coverage	Needed for 50% of Requirements		Needed for 50% of Requirements	
Estimated Annual Data Volume (185 KM Square Scenes)	2000 – 5000		8000 – 12000	

[1] MSS band 7 (0.8 – 1.1 μm) is used in analyses and has been found valuable for assessing crop vigor. The TM does not observe in the interval 0.9 – 1.1 μm. If the number and criticality of such uses is high, spectral bands will be adjusted.

[2] Very rapid data delivery is required for observations over areas affected by major hurricanes, floods, earthquakes, pollution events, and similar episodes.

[3] Most critical requirements are for data which is used by the government or industry in regional or global crop condition assessment and production forecasting.

Chapter IV

Performance Options for the Fully Operational System

Two crucial decisions relevant to the Administration's objective of having a Fully Operational System are when to begin development of a system more specifically designed to meet projected user needs on an operational basis and what additional data specification are to be met. As set forth below, the earliest that a new system can be brought into operation is 1989. A decision on when to initiate and implement the Fully Operational System requires careful examination of the Federal government's priorities, needed financial assistance, private sector interest in taking over the system, user demands during the interim Operational System and the potential risk of foreign satellite systems obtaining a portion of the domestic and foreign land remote sensing market.

This chapter explores some of the potential technical options for the Fully Operational System, including extending and improving the Landsat D-based Interim Operational System. Preliminary system studies, further discussions with users, and market and pricing assessments will have to take place before a decision can be reached on the preferred option.

While prompt resolution of the question of private sector ownership would facilitate participation by the private system operator in the design of the system, some minimal initial funding and development of key elements of the new system may have to take place simultaneously with a decision about the institutional arrangement for private sector ownership or operation in order to better meet the requirements of users.

A. System performance options

This section presents four hypothetical systems that could serve as the basis of a Fully Operational System:

(1) An extension of the Landsat D series;
(2) A "Minimum System";
(3) A "Middle System"; and
(4) A "Maximum System".

1. Common elements.—The four systems presented below differ primarily in levels of resolution, spectral bands and frequency of coverage, with all of them using more reliable, longer life solid state multilinear array sensors, rather than the mechanical scanners currently being used on the Landsat D series of satellites. User requirements for data from longwave thermal infrared, now on the Landsat D series of satellites, and microwave sensors may be most efficiently met through the modification or addition of appropriate sensors aboard NOAA's polar-orbiting environmental satellites or the National Oceanic Satellite System and will be considered by NOAA in the future design of these satellites. Operational systems for environmental and geophysical data collection from in-situ observing platforms already exist on NOAA's satellites and will be continued. Land data acquired via these and other satellites could be transmitted to the operator of the Fully Operational System for distribution to users.

The initial formats for standard data products produced by the Fully Operational System using any of these tentative designs would be similar to those produced by the Interim Operational System, although the system operator could alter the format in response to users' needs. Standard data products would be available routinely. A "quick-look" capability to asess the quality of images acquired within 12 hours of observation, and coverage of disaster events on a limited basis within 6 hours, would be desirable.

2. Options.—At this stage in the planning process, only a limited number of systems options could be examined in a preliminary conceptual fashion. The number of possible technical configurations is large. For example, existing instruments could be redesigned for improved performance, or new instruments such as imaging radars, high-resolution cameras, or thermal infrared heat detectors, could be flown. To focus this initial examination, NOAA developed data specifications having three different levels of quality and utility, drawing upon the still imprecise information on user requirements summarized in Chapter III. NOAA's synthesis of the possible data specifications for the three general classes of uses at the minimum, intermediate and maximum levels is presented in Table IV-1.

The four hypothetical systems have the following characteristics, which are set out in Table IV-2:

a. The Landsat D system

This system, which could be continued for the remainder of the century by purchasing additional spacecraft and one renewal of the ground system, has 80

meter resolution MSS bands and 30 meter resolution TM bands. The system could provide 16-day revisit time with occasional 8-day coverage when required. This is essentially the same option as the "Middle System," except for the 15 to 20 meter resolution channel, which might be added to the Landsat spacecraft. Evolutionary improvements in the Landsat D system would focus on the introduction of solid state multilinear array sensors as soon as possible and increasing satellite life to improve reliability and reduce costs.

b. The Minimum System

This system would provide coverage in four or five bands at a resolution of 80 meters. The spectral intervals would be similar to those used in TM visible bands 1, 2, 3 and 4, plus either TM shortwave infrared band 5 or 7—when technologically feasible. A band from 0.9 to 1.1 micrometers (near infrared) could be substituted for any one of these bands. Observations from TM band 3 at 40 meter resolution, as well as 80 meter resolution, would be a highly desirable addition.

This system would provide 16 or 18 day revisit time with occasional 8 or 9 day coverage when required. Each year, the system would produce a data output equivalent to about 40,000 scenes[1] equivalent to MSS scenes of an area 185 km square at 80 meter resolution, plus 10,000 selected scenes at 40 meter resolution.

This system would provide a level of service less than the Landsat D system.

c. The Middle System

This system would provide coverage in the same bands as the Minimum System at two different resolutions: 30 or 40 meters and 60 or 80 meters. The lower resolution will be half that of the higher resolution in order to facilitate use of a single sensor and simplify on-board data processing. As soon as technology allows, TM shortwave infrared bands 5 and 7 would be added at both resolutions. Observations from TM band 3 at 15 or 20 meter resolution would be a highly desirable addition.

This system would provide an 8 or 9 day revisit frequency most of the time. In addition, imaging sensors could be steerable to avoid cloudy areas or to pick up areas which were covered with clouds at the regular viewing time. The number of scenes processed each year would be 40,000 equivalent scenes at 60 or 80 meters resolution and 20,000 equivalent scenes at 30 or 40 meters resolution; 10,000 equivalent scenes at 15 or 20 meters resolution would be gathered from limited areas.

This system, without 15 or 20 meter resolution, would provide a level of service essentially equivalent to the Landsat D system.

d. The Maximum System

This system would provide coverage in the four TM visible bands 1 through 4, at a resolution of 10 meters, plus TM shortwave infrared bands 5 and 7 at 20 meters resolution. On board data processing also would provide data at 40 and 80 meters. The latter would provide regular coverage of global land masses; the 10 and 20 meter data would be gathered from limited areas.

This system would produce global coverage equivalent to about 40,000 MSS scenes at 60 or 80 meters resolution, plus 40,000 equivalent scenes at 30 or 40 meters resolution. About 40,000 scenes of areas about 90 km square would be produced at the full resolution of 10 or 20 meters.

This system would provide a level of service far in excess of the Landsat D system.

A supplement to this system would be necessary to meet the need for data from a single panchromatic spectral band at a resolution of 2 meters. Such a system would require a much lower orbit than is planned for the other missions and thus could not be a shared satellite. The ground system would be specially designed for data at 2 meter resolution, with an output of 40,000 scenes 20 km square per year.

Stereo capability might be provided in one of two ways:

Stereo adaptation of the multilinear array imaging system in TM spectral band 3, or the addition of electronic camera systems similar to the Return Beam Vidicon to the Middle or Maximum System spacecraft; or

Separate spacecraft specially designed for stereo coverage, with either film or electronic imaging, which could be flown as infrequently as every 10 years.

The minimum capability of the stereo system would be coverage of the Earth's land mass with 30 meter stereo heighting capability once every 10 years. This

[1] As used here, "scenes" means usable scenes. Approximately twice as many scenes must be carried through the early pre-processing stage to eliminate those with cloud cover or other defects. This estimate reflects current experience with Landsats 1, 2 and 3.

coverage could be improved to include imagery acquired in each of the four seasons and to raise the stereo heighting capability to 15 meters.

3. Cost estimates.—Only approximate estimates can be made of system costs at this time. They do not include NASA and NOAA system development, market expansion, or planning and management costs, nor do they include the cost to add a longwave thermal infrared or advanced microwave sensors to the operational system. Rough estimates of ten-year capital and operating costs of the full systems at each level are:[2]

$2.0 billion for Landsat D continuation;
$1.0–$1.5 billion for the Minimum System;
$1.5–$2.5 billion for the Middle System;
$3.0–$5.0 billion for the Maximum System; and
$4 to $5 billion additional for the 2 meter system.

While any estimate at this time is premature, the thermal infrared capability, with a resolution on the order of 100–200 meters, probably can be added to an existing operational spacecraft without exorbitant cost. The additional cost to produce one global set of satellite stereo data is estimated to be $200 to $400 million for 30 meter stereo heighting capability and $300 to $700 million for 15 meter stereo heighting capability.

These estimates assume that:

The spacecraft will be launched and retrieved by shuttle;
Retrieved spacecraft will be refurbished for reuse;
Data will be relayed to ground via geostationary satellites; and
Highly reliable, all solid state sensors and onboard data storage devices will be used, with sufficient redundancy to achieve a goal of five-year life for each spacecraft mission before the end of the ten-year operational period.

4. Timing considerations.—Initiation of any of these operational system alternatives is highly dependent on the development of reliable sensor and other spacecraft subsystem components needed to achieve long life for each spacecraft and initiation of detailed system trade-off studies and system design. The Minimum or Middle System probably could be launched by the end of this decade if necessary R&D and initial system studies are initiated in the next few years. A tentative schedule based on a new spacecraft appears in Table IV–3. This development period might be one year less if the shortwave infrared channels are omitted on the first spacecraft and a shorter life for the initial spacecraft is accepted. The improved Landsat D system could also be launched in 1989, as soon as the solid state sensors have been developed and integrated into the Landsat D spacecraft, as shown in Table IV–4. The Maximum System would take at least two additional years to implement.

Stereo capability can be included in the same general time frame. If existing techology is used with a dedicated spacecraft and ground system for stereo capability and full funding is made available for design in fiscal year 1982 and construction in fiscal year 1983, a launch as early as 1988 may be feasible.

B. Initial evaluation

The following provides an initial, very tentative evaluation of the hypothetical options. Decisions on performance specifications will only emerge from the lengthy interactive process between preliminary system design, user requirements analysis and cost estimating that will be a part of the ongoing planning process for the Fully Operational System.

The Minimum System does not appear to meet the currently stated needs of the majority of users, especially with respect to resolution, which is particularly important for the renewable resources and environmental management user groups. It has lower performance characteristics than even the Landsat Thematic Mapper, which will be used for the Interim Operational System, and would amount to a regression in the quality of available data. It would not come close to meeting the competition that may be provided by the French and the Japanese systems, so both U.S. technological leadership and a large part of the market for U.S. data and standard data products could be lost. A system with this level of performance probably would not be worth the investment.

The upgraded Landsat D system and the optimum Middle System are relatively similar in cost and performance. Indeed, additional system study may show that the basic multi-mission modular spacecraft (MMS) used for Landsat D can be improved to serve as the optimum Middle System spacecraft. These systems would have to provide higher operational reliability, incorporate the latest technology and lower average annual costs through longer spacecraft life if users are expected to forego other data sources in favor of land remote sensing satellite data. A 15 meter TM

[2] All costs are in fiscal year 1980 dollars.

band 3 with twice the resolution offered by the 30 meter TM band on the Landsat D could be desirable. In addition, the development by 1989 of an all solid-state multi-linear array system with a 15 meter TM band 3 would place the U.S. at least on a par with the French and Japanese systems, which are scheduled to begin operation in the mid-1980s.

The Maximum System meets virtually all stated user needs, but at a cost that users will probably not be willing to pay. Until experience is gained with the data from the TM system and more widespread use of land remote sensing satellite data develops, the additional value of the refinements offered by this system is somewhat speculative. Morover, the development of the Maximum System will take at least an additional two years.

To reach firm decisions on system specifications will require further analysis of user requirements, including stereo requirements, the marginal costs of various additional capabilities, the establishment of budget priorities and the mechanisms for system financing.

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TABLE IV-1
POSSIBLE DATA SPECIFICATIONS BY CLASS OF USES

MINIMUM ACCEPTABLE LEVEL	RENEWABLE RESOURCES	NON RENEWABLE RESOURCES	PLANNING AND ENVIRONMENTAL MANAGEMENT
Resolution (1)	80 m, TM bands 1, 2, 3, 4, plus	80 m, TM bands 1, 2, 3, 4, plus	80 m, TM bands 1, 2, 3, 4, plus
Spectral Bands (2)	TM 5 or MSS band 7	TM 5 or MSS band 7	TM 5 or MSS band 7
		30 40 m, TM band 3 or 4	30 40 m, TM band 3 or 4
Repeat coverage	8 9 days	about one month	about one month
Data delay	two days	four weeks	one week
Quick look	yes	yes	yes
Tasking system	yes	yes	yes
Cover special events (3)	yes	yes	yes
INTERMEDIATE LEVEL – **Includes minimum level specified above plus the following:**			
Resolution (1)	Both 80 and 30 40 m	Both 80 and 30 40 m	Both 80 and 30 40 m
Add'l Spect. band	TM 7 (short wave IR)	TM 7	TM 7
Pick up missed scenes on adjacent tracks	yes	no	yes
Stereo heighting	30 m	30 m	30 m
MAXIMUM LEVEL – **Includes the minimum and intermediate levels plus the following.**			
Resolution (1)	derived 80 m and 10 m	derived 80 m and 10 m	derived 80 m and 10 m
Add'l Spect. band	TM 6 thermal IR (4)	TM 6 thermal IR (4)	TM 6 thermal IR (4)
Repeat coverage	increase to 5 to 7 days		
Stereo heighting	increase to 15 m	increase to 15 m	increase to 15 m

(1) Coverage of all of the earth's land masses desired at 80 m resolution; more limited, selected coverage on demand at the higher resolution specified. Resolutions given as instantaneous field of view (IFOV). USDA requires 2 m resolution of selected scenes on demand.
(2) See listing below which defines the spectral intervals of the Landsat Multispectral Scanner (MSS) and Thematic Mapper (TM) bands.
(3) One day maximum delay for delivery of critical data on such events as floods and earthquakes.
(4) Preferably on another satellite with an orbit that provides coverage at a different time of day.

Multispectral Scanner (MSS)		Thematic Mapper (TM)		
Channel No.	Spectral Interval	Spectral Interval	Channel No.	Band description
		0.45 0.52 μm*	1	blue green
4	0.5 0.6 μm*	0.52 0.60	2	green
5	0.6 0.7	0.63 0.69	3	red
6	0.7 0.8	0.76 0.90	4	near infrared (IR)
7	0.8 1.1			near infrared
		1.55 1.75	5	"Short wave" IR
*Wavelength in micrometers		2.08 2.35	7	"Short wave" IR
		10.40 12.50	6	"long wave" thermal IR

TABLE IV-2
PERFORMANCE CHARACTERISTICS OF THE HYPOTHETICAL LANDSAT-D, MINIMUM, MIDDLE, AND MAXIMUM OPTIONS

	LANDSAT D SERIES	MINIMUM SYSTEM	MIDDLE SYSTEM	MAXIMUM SYSTEM	HIGH RESOL. SYSTEM
"TM-bands"					
1 0.45 - 0.52 μm	30 m	80 m	30 m	10 m	
2 0.52 - 0.6 μm	30 m	80 m	30 m	10 m	(Panchro-
3 0.63 - 0.69 μm	30 m	80 and 40 m	30 and 15 m	10 m	matic)
4 0.76 - 0.9 μm	30 m	80 m[2/]	30 m[2/]	10 m[2/]	2 m
5 1.55 - 1.75 μm	30 m	one band	30 m	20 m	
7 2.08 - 2.35 μm	30 m	80 m	30 m	20 m	
6 10.4 - 12.5 μm	120 m	[3/]	[3/]	[3/]	
"MSS-bands"					
4 0.5 - 0.6 μm	80 m				
5 0.6 - 0.7 μm	80 m				
6 0.7 - 0.8 μm	80 m				
7 0.8 - 1.1 μm	80 m[2/]				

1/ Figures in table are instantaneous-field-of-view (IFOV) in meters.

2/ MSS Band 7 (0.8 - 1.1 μm) is valuable in crop vigor analyses. The TM does not observe in the interval 0.9 - 1.1 μm. If the number and criticality of such uses is high, spectral bands will be adjusted.

3/ Thermal IR coverage may be provided, if required, by a sensor from another civil satellite.

4/ On-board processing to provide data at integral multiples of stated resolution could be considered to reduce data rates where desired.

5/ Stereo coverage, either by pointing of the primary sensor or by periodic inclusion of a framing instrument could be considered for both the middle and maximum systems.

TABLE IV-3
TENTATIVE FULLY OPERATIONAL SYSTEM UTILIZING
NEW SPACECRAFT AND SENSORS

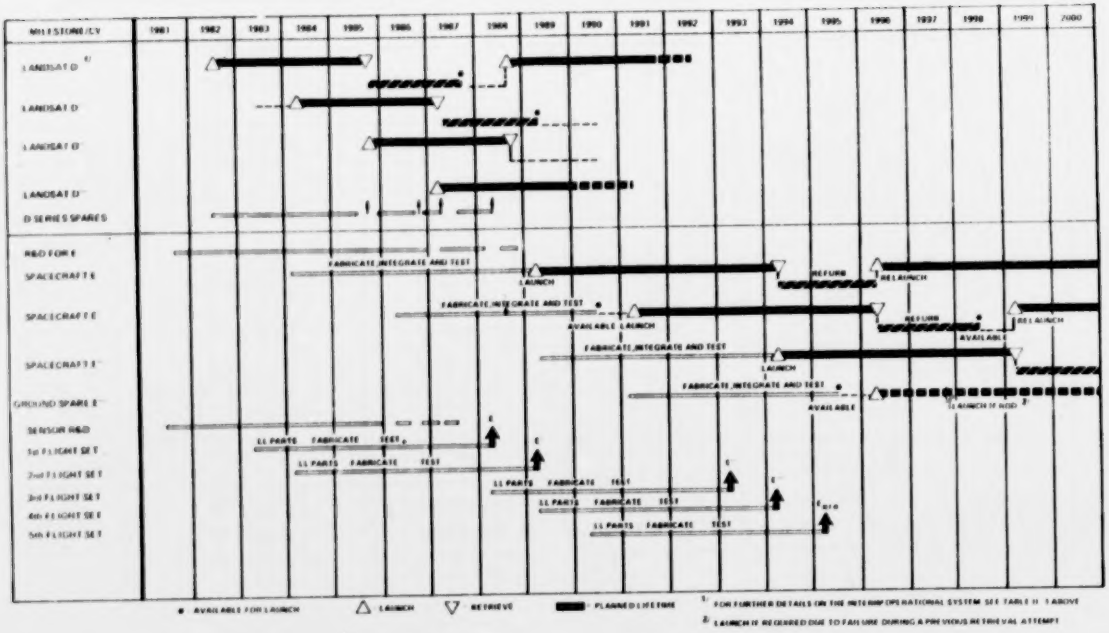
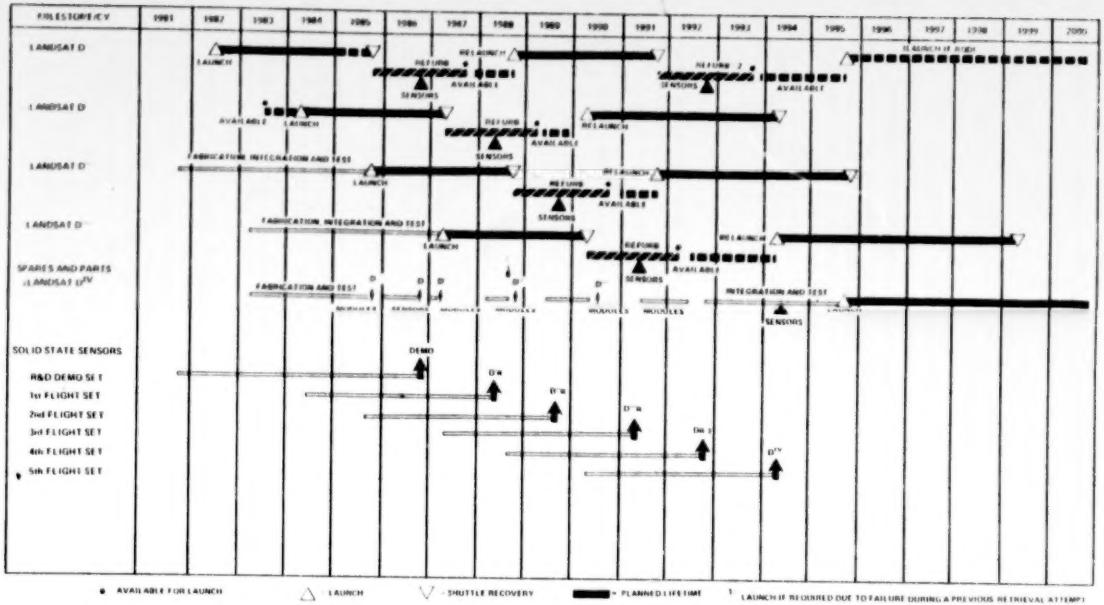


TABLE IV-4
TENTATIVE FULLY OPERATIONAL SYSTEM UTILIZING CONTINUED LANDSAT-D SERIES SPACECRAFT (NEW SENSOR INTRODUCED ON REFURBISHMENT)



CHAPTER V

REVENUES, PRICING POLICIES, AND FINANCIAL ASSISTANCE

The Administration has established as a national goal eventual ownership and operation by the private sector of our civil land remote sensing activities, and directed NOAA to plan for system financing including pricing policies for the users sharing of costs. Accordingly, marketplace objectives should play a significant role in the design and management of the Interim and Fully Operational Systems, although a number of other considerations, such as the desire to assure U.S. technological leadership, will also shape the final decisions.

This chapter examines the Interim and Fully Operational Systems from a business point of view that requires the generation of revenues to recover capital and operating costs and to provide a reasonable return on capital through the provision of a valuable service to users. The chapter identifies the policy choices involved and the nature of the Federal financial commitment that may be required for private sector ownership, reviews the revenue currently projected to result from new pricing policies and potential market expansion activities and discusses alternative mechanisms for capital and operating assistance. Finally, the chapter examines alternative approaches to sharing the burden of Federal financial assistance among the Federal agencies.

A. Projected revenues and costs

Revenues of the operational system will be generated by sales of data and standard data products and by foreign ground station access fees. The current price of data and standard data products is based upon the cost of reproduction, with no attempt being made to control additional reproduction by users, so that a computer compatible tape costs $200 and various types of Landsat images cost between $8 and $50.[1] The current access fee is a nominal annual payment of $200,000 per station. In 1978, the current Landsat system generated $4 million from sales and access fees of $1.8 million for a total of nearly $6 million in annual revenues. Of the $4 million, $2.7 million was derived from sales and $1.3 million is the value attributed to the data distributed without charge.

A hypothetical five to ten fold price increase, phased in over a period of some years, assuming the increases are absorbed without any significant overall loss of sales to competing sources of data (such as aerial photography, field party surveys and foreign land remote sensing satellite systems) could increase revenues over time to $30–60 million per year simply by raising prices.[2] In addition, assurance of data continuity and reliable delivery of data and standard data products combined with a market expansion program discussed in Chapter VII, should enhance the prospects for growth in unit sales volume. If one assumes a hypothetical 10 percent growth in data sales per year and only a hypothetical 5-fold increase in both the price of standard data products and foreign station direct reception fees, then by the year 2000, annual revenues of $140 million would be generated by the system. Unfortunately, reliable projections of market growth and price elasticity are not possible at this time. However, the doubling of current unit sales at higher prices is a possible goal.

The tentative estimates for the hypothetical Fully Operational System options, described in Chapter IV, indicate that approximately $100 million to $400 million or more in annual revenue would be necessary, depending on the technical capabilities of the system selected, to cover total annual costs. They include operating and maintenance costs, replacement of capital equipment, dividends, taxes, interest on debts, marketing, insurance, and a reasonable return on initial capital.

Similar tentative estimates covering the remaining total annual costs for the Interim Operational System indicate that approximately $150 million in annual revenue would be necessary to cover total annual costs.

B. Pricing policies

1. Standards.—The pricing of data and standard data products from the Interim and Fully Operationals System should conform as much as possible to the following standards:

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[1] All revenues are in fiscal year 1980 dollars.

[2] Whether subsequent reproduction of dissemination of data products by Federal agencies and other users would need to be conditioned upon payment of fees to make prices well above cost of reproduction meaningful remains to be seen. This matter is addressed under the heading "Control Over Data and Standard Data Products" in Chapter VI, Section B.1.

a. Consistency

Pricing policies should be developed that are consistent for foreign and domestic users. Foreign and domestic users, with the possible exception of the Federal agencies who might pay higher prices as a form of financial assistance (as discussed below), should pay the same price for the same product and associated services. Fees charged to foreign ground stations receiving data directly should be set to encourage consistency between prices for domestic and foreign standard data products.

b. Assistance to Special Users

Certain classes of users whose data usage is in the public interest may be driven out the market by higher prices. While the policy of consistency precludes discounts, such users could seek direct Federal grants to enable them to purchase needed land remote sensing satellite data at established prices, in special and selected circumstances.

c. Market development

Especially during the Interim Operational System, prices should be established in a manner to increase the volume of unit sales without losing a major customer demand. Price changes should be announced well in advance so that users, especially those dependent on governmental appropriations processes, can plan their budgets accordingly.

2. Fee Structure.—Examples of the types of fees the operator of the Interim and Fully Operational Systems could charge for data and standard data products are:

Basic fee: A fee paid by each user on each standard data product it purchases from the U.S. system operator. These fees would vary in proportion to the cost incurred in producing that product. They would be paid by users of both real time and retrospective data. Other factors such as timeliness, the placing of special orders and special handling could be reflected in a surcharge schedule.

Royalty fee: A fee paid by each U.S. and foreign user and foreign ground station operator on the reproduction or resale of Landsat standard data products.

Direct reception fee: One or more fees paid by foreign ground station operators receiving date directly from U.S. land remote sensing satellites. Examples of such fees are: (1) an annual access fee like the $200,000 fee per station per year currently being paid by Landsat station operators, and (2) a transmission fee paid by foreign ground station operators for data transmitted to and received by the foreign ground stations. This latter fee would be based on the amount of data requested.

A further study of pricing options will be made during fiscal year 1980 and fiscal year 1981 for review by the Program Board and the Land Remote Sensing User Advisory Committee.

3. Price levels.—The objective of users sharing of the costs of the operational system precludes a continuation of the present policy of limiting prices to the cost of reproduction and leaving user reproduction completely uncontrolled.[3] While specific price levels for specific products cannot reasonably be established without more detailed study, two approaches to pricing during the Interim Operational System are being considered:

Option 1. Price Increases Designed to Maximize Revenues

NOAA would raise prices when it assumes responsibility for the Interim Operational System to levels designed to maximize immediate revenues from sales. For instance, price increases effective in fiscal year 1983 would be announced in fiscal year 1981 as a result of preliminary pricing studies, and would be confirmed through contracted market studies in fiscal year 1982.

Pros:

Generates revenue to help offset recurring costs of the Interim Operational System.

Tests the market for land remote sensing data at relatively high prices early enough to provide some feedback to decisions with respect to the Fully Operational System, including the potential for private sector investment.

Cons:

Foregoes introductory pricing to develop the market; could price some users out of the market and discourage new users.

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[3] Some users oppose increasing prices above the present cost of reporduction level, which they believe maximizes the public benefit.

Creates an opportunity for market penetration by foreign land remote sensing satellite systems.

Factual information on price elasticity for data and standard data products cannot be obtained until the Interim and Fully Operational Systems are more clearly defined.

Option 2. Price Increases Phased to Promote Development

NOAA would raise prices on a phased basis when it assumes responsibility for the Interim Operational System. Data and standard data products would be priced at levels initially designed to encourage potential users to invest in support equipment and to reduce the use of competing methods of data collection.

Initial price increases effective, for instance, in fiscal year 1983 would be announced in fiscal year 1981 as a result of preliminary pricing studies. Price increases for fiscal year 1984 and subsequent fiscal years would be developed through contracted market studies in fiscal year 1982 and announced in late fiscal year 1982. Notification of price increases well in advance would be provided to test demand without distortion from temporary budget shortfalls resulting from unanticipated price changes.

Pros:

Factual information on price elasticity for data and standard data products cannot be obtained until the Interim and Fully Operational Systems are more clearly defined;

Users acquire data at rates that will allow them to assess its utility to their operations and make long-term commitments; and

Long-term increases in market volume, through encouragement of new users and avoidance of pricing some existing users out of the market, may generate greater revenues for the Fully Operational System.

Cons:

A lower revenue flow may result during the early phases of the Interim and Fully Operational Systems, possibly discouraging private sector investment.

C. Financial assistance

The Federal government could reduce the gap between the revenues and the total annual costs that likely would be experienced by a private operator or a government corporation in a number of ways, ranging from providing some or all of the initial capital to agreeing to pay higher prices for the data and standard data products it uses. To the extent that the Federal government chooses to provide or underwrite initial capital, the level of operating assistance can be correspondingly reduced, and vice versa. Actual outlays for operating assistance unlike capital assistance, can be deferred until the system begins to deliver products, if an advance commitment guarantees the operator a market for its products.

The following paragraphs briefly identify the primary capital and operating assistance techniques:

1. Capital assistance.—

a. Grants

The Federal government could give one or more grants to a private operator or a government corporation, which would require neither the payment of dividends or interest nor repayment of principal, and would thereby directly reduce the revenues required to meet costs. Federal grants as direct payment might be unattractive in tight budget times as compared with equity or loan guarantees.

b. Equity Guarantees

A private operator could raise capital in the private financial market by issuing stock at a Federal government-guaranteed minimum price. The Federal government could purchase any unsold stock at the end of a specified period at the guaranteed price and could stand ready thereafter to repurchase that stock at that same price. Such a price guarantee might make the stock offering of a private operator attractive enough at the outset so that all stock would be purchased by private investors.

c. Government Loans and Loan Guarantees

The Treasury Department or the Federal Financing Bank could make loans to a private operator by buying corporate bonds, or NOAA could guarantee loans made to a private operator or to a government corporation by the Treasury Department, the Federal Financing Bank, private investors, or all three. All such loans, except those from private investors, would involve interest rates at or near Treasury rates,

which could be well below the market rate. The interest rates on private loans guaranteed by NOAA would be somewhat higher depending upon market conditions.

2. Operating assistance.—

a. Federal Purchase Guarantees

NOAA could contract with a private operator or a government corporation for a specific flow of land remote sensing satellite data and standard data products designed to meet the minimum data needs of all Federal users over a period of several years at prices that would ensure that revenues from these purchases cover virtually all the costs of operation. Other users probably would be charged lower prices, since the operator (and therefore the Federal government) would benefit from sales at any price above direct production costs for the additional standard data products. Federal users could purchase additional standard data products at current market prices at any time.

b. Overall Price Assistance

The Federal government could agree to pay a private operator or a government corporation a fixed amount for each unit of data or standard data product sold to all or specific groups of users. The amount could be adjusted periodically based on an evaluation of the corporation's operations.

c. Appropriations

The Federal government could provide funds to a private operator or to a government corporation to increase the revenue stream sufficiently to assure cost recovery. The amount could vary annually or be fixed at the outset on the basis of a projection of long-term needs. In the latter case, the corporation would retain a full incentive to reduce costs and increase revenues.

d. Free Services

The Federal government could provide launches, data transmission service from the satellite to the ground facility via TDRSS, or insurance for space hardware to a private corporation or a government corporation, thus reducing the corporation's costs substantially.

e. Tax Incentives

Accelerated depreciation or additional investment tax credits could be granted to a private operator to reduce its taxes. Since this form of assistance is not useful if the private operator has no tax liability, tax incentives would be effective only for an operator with taxable income from land remote sensing or other operations.

The appropriate financial assistance mechanism may depend on the institutional option selected. Various institutional options and assistance mechanisms are considered in Chapter VI.

D Appropriation of Federal financial assistance costs

Three possible options exist for allocation of the Federal financial assistance costs among the budgets of NOAA and the Federal user agencies:

Option 1. NOAA Budgets All Funds

NOAA would be responsible for obtaining appropriations for that portion of the capital and operating costs of the "core" Interim and Fully Operational Systems not covered by revenues as an add-on to its existing budget. In addition, NOAA would seek funds for any optional components beyond the core system that are required to meet the special needs of users, such as, for example, stereoscopic or other special sensors, or more frequent coverage.

The pros and cons of Option 1 are:

Prose:

Provides NOAA with leverage to establish priorities among users' technical requirements;

Focuses responsibility for policy and budget development and presentation in a single agency; and

Focuses policy and budget review in four Congressional subcommittees.

Cons:

Fails to provide adequate incentives for user agencies to make tradeoffs between satellite and other data sources, and between programs utilizing land remote sensing satellite data and other mission programs;

Focuses program justification in NOAA's Congressional committees, thereby diluting the influence of the constituencies of user agencies;

Requires justification of special system capabilities before Congressional subcommittees that are not necessarily knowledgeable about the specific requirements of the individual user agencies.

Option 2. NOAA Budgets "Core" System Funds: User Agencies Budgets Special System Capabilities

NOAA would obtain appropriations only for that portion of the capital and operating costs of the "core" Interim and Fully Operational Systems not covered by revenues as an add-on to its existing budget. These "core" systems would include the space and ground segment elements necessary to meet the common needs of the majority of users. The costs for any special system capabilities, such as stereoscopic or other special sensors or more frequent coverage, would be budgeted by the user agencies that want these capabilities.[4]

The pros and cons of Option 2 are:

Pros:

Provides NOAA with leverage to establish priorities among users' technical requirements for the core system;

Focuses responsibility for policy and budget development and presentation for the core system in a single agency;

Focuses policy and budget review of the core system in four Congressional subcommittees;

Provides incentives for user agencies to make cost tradeoffs with respect to the special system capabilities between satellite and other data sources, and between programs utilizing land remote sensing satellite data and other mission programs; and

Requires agencies with special needs to justify provision of any special system capabilities.

Cons:

Fails to provide incentives for user agencies to make cost tradeoffs between satellite core system and other data sources;

May require NOAA to coordinate budget presentations with one or more other agencies and complicates the budget approval process;

Requires justification of special system capabilities before additional sets of authorization and appropriation committees that are not necessarily knowledgeable about land remote sensing from space; and

Focuses program justification for the core system in NOAA, thereby diluting support from the constituencies of other agencies.

Option 3. User Agencies Fund All System Funds

The major Federal user agencies would obtain the appropriation of their proportionate share of that portion of the capital and operating cost of both the "core" and any special system capabilities of the Interim and Fully Operational Systems not covered by revenues.

The pros and cons of Option 3 are:

Pros:

Provides maximum incentives for Federal user agencies to make cost tradeoffs between satellite and other data sources, and between programs utilizing land remote sensing satellite data and other mission programs;

Most fairly distributes costs based on expected use;

Brings to bear the constituency influence of the user agencies;

Shows commitment of Federal user agencies to the benefits of this program; and

Gives participating agencies more leverage in setting priorities.

Cons:

Limits NOAA's effectiveness in establishing priorities between users' technical requirements;

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[4] In addition, joint funding arrangements with the private sector could be negotiated.

Splits responsibility for program and budget review among many Congressional subcommittees;

If one Federal user agency withdraws from or loses Congressional support for the program, costs to the remaining agencies would increase unexpectedly, or the System could be jeopardized;

Makes NOAA's technical defense of the budget difficult due to the large number of concerned Congressional committees; and

Would lessen the probability of non-Federal user requirements being considered in the design of the system.

CHAPTER VI

INSTITUTIONAL APPROACHES TO PRIVATE SECTOR INVESTMENT AND MANAGEMENT

Four principal institutional alternatives are examined in this Chapter for meeting the goal of eventual operation by the private sector of the U.S. civil operational land remote sensing satellite activities. In addition to these alternatives, the need for legislative policies to guide a private sector owner in its operation and for the establishment of a regulatory framework to oversee any private owner's activities are discussed.

A. Institutional alternatives

Four major options have been identified for achieving some degree of private sector operation of the U.S. civil land remote sensing satellite system. These options are:

A private corporation;

A legislatively established for-profit private corporation;

A government corporation with private sector operation and with a subsequent transfer to the private sector; and

Federal agency ownership with private sector operation and with a subsequent transfer to the private sector.

These options were developed in part and reviewed at two workshops conducted with representatives of a broad cross-section of private corporations interested in the land remote sensing satellite program. An initial assessment of some pros and cons of these options is set forth below.

Option 1. Private corporation.—A private corporation or a consortium of private corporations would be selected to own and operate all or a part[1] of the Fully Operational System. This arrangement would have the following attributes:

A private corporation would be selected through a competitive process to own and manage the system for a specific period of time. Re-competition would occur at the end of this period;

The private corporation's own management and board of directors would be responsible for managing the system; and

The capital needed to develop and build the system would be provided through private equity, private debt investments and corporate retained earnings. No Federal loans or loan guarantees would be provided.[2]

A portion of the system's revenues would be provided by a long term Federal contract guaranteeing purchases of the standard data products required to meet the government's needs;[3]

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[1] Industrial interest in owning and operating the U.S. civil land remote sensing satellite system varies. Two companies have expressed interest in owning and operating both the space and the ground segments. Other companies, depending on whether they are aerospace or data processing companies, have expressed interest in either the space segment or the ground segment, with the Federal government owning and operating the other segment. In addition, interest has been expressed among mineral and petroleum companies in a specialized satellite system that would provide stereoscopic data.

[2] Industry representatives are in agreement that, in the absence of Federal data purchase guarantees, this option is not viable at this time because of the projected gap between system revenues and system costs and the uncertain market during the 1980s. Their preferred Federal assistance appears to be a long-term service contract by which the Federal government would guarantee a certain annual income to the private corporation, for perhaps a ten-year period, in return for having its requirements for standard data products met. The Department of the Navy's Leasesat is an example of this approach. The private corporation would be required to meet non-Federal user requirements and would assume the associated business risk.

[3] The contract terms would provide the necessary financial assistance by setting the prices to be paid by the Federal government for its basic data needs at a sufficiently high level to make cost recovery feasible. Alternatively, the quantities of data, but not the prices, could be specified, with a separate fixed subsidy in addition.

The private corporation would assume the risk of recovering the remaining percentage of its capital and operating costs, plus a profit, through an aggressive market development program;[4]

The private corporation would be regulated by NOAA to ensure compliance with U.S. nationa and international policies.[4]

The pros and cons of Option 1 are set forth below:

Pros:

Would achieve the goal of private sector ownership and operation at the earliest possible time;[5]

Could place some of the financial risks in the private sector.

Would defer Federal outlays for the fully operational system through use of a long-term data purchase contract by whose terms control over the private owner's activities could be established.

Would provide a strong profit incentive for vigorous market development and system efficiency.

Might be more responsive to market demands than the Federal government since a private corporation is likely to spend more resources on market development.

Would permit Federal reassessment of this option at the end of the contract period.

Cons:

Would probably be infeasible unless long-term Federal purchase guarantees were given.

The Federal government would be able to appoint members to the private corporation's Board of Directors to ensure Federal participation in the day-to-day direction of a system largely serving Federal needs and largely funded with Federal monies.

Changing Federal information needs might not always be met by a private corporation.

A private corporation owning the space segment and the resulting data could cause foreign concerns about abuse, possibly leading to adverse foreign and space policy consequences.

Could make it more difficult to achieve the goal of complementarity with foreign operated satellite systems, since limited Federal control of the private corporation's satellite activities would exist.

Could make it more difficult to achieve potential savings by integrating atmospheric and oceanic operational remote sensing satellite activities with those for land remote sensing.

In the absence of sizeable Federal capital and operating subsidies, the competitive process for ownership and operation of the system would be limited to a few very large corporations.

Those large corporations who would respond to a competitive selection process might have potential conflicts of interest as users or as system providers with the operation of a land remote sensing satellite corporation.

Option 2. Federal Establishment of a For-Profit Private Corporation

The Federal government, through legislation, would establish a for-profit private corporation to own and operate all or a part of the U.S. civil land remote sensing satellite system. This corporation would have the following attributes:

Federal and non-Federal representation would be provided on its Board of Directors.

The capital needed to develop and operate the system would be provided through the sale of capital stock and debt obligations in the private financial market or through the Federal Financing Bank and the Department of the Treasury.[6] If all the corporation's stock were not purchased on the private market within a predetermined period, the enabling statute could provide for government purchase of a

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[4] NOAA would need authorizing legislation to enable it to regulate any private system operator, to enter into a long-term service contract on behalf of Federal user agencies and appropriations to finance any long-term service contracts.

[5] Transfer of Federal land remote sensing equipment or designs to private ownership may be inhibited by the possible existence of contract restrictions protecting equipment suppliers against the transfer of such technology.

[6] NOAA would need authorizing legislation to enable it to obtain up-front appropriations covering any government loan.

limited percentage of the unsold stock or for the withdrawal of the stock offering and use of another option.[3]

Stock ownership by private corporation active in the aerospace, data processing and value-added service fields would be limited to a specific percentage of the corporation's stock.

A portion of the corporation's revenue would be provided through a long-term Federal service contract guaranteeing purchase of the standard data products required to meet the Federal government's needs.

The corporation would assume the risk of recovering the remaining percentage of its capital and operating costs, plus a profit, through an aggressive market development program.

The corporation would be precluded from itself building the space and ground segments and would be required to procure its hardware and software through a competitive bidding process.

The corporation would be regulated by NOAA to ensure compliance with U.S. national and international policies. The statute also could provide for periodic Federal review of the corporation's affairs.

The Pros and Cons of Option 2 are set forth below:

Pros:

Would achieve the goal of eventual private sector ownership and operation earlier than Options 3 and 4.[4]

Would ensure Federal participation in the day-to-day management of a system largely serving Federal needs and largely funded with Federal monies.

Would spread financial risks among private investors, private lenders and the Federal government.

Use of a long-term data purchase contract would defer Federal outlays for the Fully Operational System, although any Federal equity participation would require immediate outlays.

Would provide a strong profit incentive for vigorous market development and system efficiency.

Might be more responsive to market demands than the Federal government since a private corporation is likely to spend more resources on market development.

Cons:

Once the corporation is established, the Federal government might be committed to its continued support for an indefinite period of time if it turned out to be unsuccessful financially.

Would create a statutory monopoly, limiting entry into the market by other private corporations for the foreseeable future.

Although less likely to cause serious concern than Option 1, a legislated private corporation owning the space segment and the resulting data is more likely than Options 3 and 4 to raise foreign concerns about abuse, possibly leading to adverse foreign and space policy consequences.

Might make it more difficult to achieve the goal of complementarity with foreign operated satellite systems than under Options 3 and 4.

Might make it more difficult to achieve potential savings by integrating civil atmospheric and oceanic operational remote sensing satellite activities with those for land remote sensing than under Options 3 and 4.

Option 3. Federal Establishment of a Wholly-Owned Government Corporation with a Subsequent Transfer to the Private Sector

The Federal government would establish a wholly-owned government corporation to own and operate the U.S. civil land remote sensing satellite system. This corporation would have the following attributes:

The corporation would report to the Secretary of Commerce.

Federal and non-Federal representation would be provided on its Board of Directors.

The members of the Board of Directors would be appointed by the President or the Secretary of Commerce.

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[3] If necessary, the statute could authorize the Federal government to guarantee a base price for the shares of stock purchased by the general public. However, such a guarantee would significantly limit the assumption of risk by the private sector under this option. If not enough stock was purchased, the desirability of moving forward with such an institution would have to be reassessed.

[4] Transfer of Federal land remote sensing equipment or designs to private ownership may be inhibited by the possible existence of contract restrictions protecting equipment suppliers against the transfer of such technology.

The capital needed to develop and operate the system would be provided through government purchase of the equity interest in the corporation and through the sale of debt obligations in the private financial market or through the Federal Finance Bank and the Department of the Treasury.

A portion of the corporation's revenue would be provided through a long-term Federal service contract guaranteeing purchase of the standard data products required to meet the Federal government's needs.

The corporation would assume the risk of recovering the remaining percentage of its capital and operating costs through an aggressive market development program.

The corporation would be precluded from itself building the space and ground segments and would be required to procure its hardware and software through a competitive bidding process.

The corporation would be managed so as to ensure compliance with U.S. national and international policies. The statute also would provide for periodic review of the corporation's affairs.

The corporation would be transformed into a for-profit private corporation through the sale of its stock or the disposition of its assets to a private corporation or consortium as system revenues warrant.

The Pros and Cons of Option 3 are set forth below:

Pros:

Transition to private sector financing and management of the system could occur when system revenues so warrant.

Would continue close Federal management and control of a system for which Federal entities are currently the largest users.

Could make it easier than Options 1 or 2 to achieve the goal of complementarity with foreign operated satellite systems.

Foreign concerns about abuse would be less likely than with Options 1 and 2.

Offers greater potential for integration of atmospheric, oceanic and land remote sensing satellite activities than Options 1 and 2.

Cons:

Would not immediately achieve the goal of private sector ownership.

Would create another government program, restricting participation by private corporations to equipment or service contracts.

Would place all financial risks on the government.

Would not provide as strong an incentive for recovering all costs through data and product sales since, historically, the market development programs of Federal agencies have been unsuccessful.

Option 4. Federal Agency Ownership With Private Sector Operation with a Subsequent Transfer to the Private Sector

As the Federal program manager, NOAA would develop and own the U.S. civil land remote sensing satellite system and private corporations would operate all or a part of the system under contract with NOAA. When the system becomes financially viable, it would be transferred to the private sector. The option involves the following:

A private corporation would be selected through a competitive process to operate all or a part of the system for a specific period of time. Re-competition would occur at the end of this period.

The government would be responsible for the capital and operating costs of the system.

Users would pay the Federal government fees for data and standard data products.

Transfer to private sector ownership would take place when the system becomes financially viable.

The Pros and Cons of Option 4 are set forth below:

Pros:

Would ensure maximum Federal control of a system largely serving public needs and largely funded with Federal monies during the period of Federal ownership.

Could make it easier to achieve the goal of complementarity with foreign operated satellite systems during the period of Federal ownership.

Could minimize foreign concerns about abuse during the period of Federal ownership.

Could enhance potential for savings through integration of atmospheric, oceanic and land remote sensing satellite activities during the period of Federal ownership.

Would permit Federal reassessment of private sector ownership options after the implementation of the Interim Operational System.

Cons:

Would achieve the goal of eventual private sector operational involvement, but would not do so now.

Transition to private sector financing and managment of the system would be deferred at least until the early 1990s or until an industry proposal is accepted.

Would place all financial risks for development of the first Fully Operational System on the government.

Would require appropriations of initial Federal outlays for the Fully Operational System in 1982.

Would not provide as strong an incentive for recovering all costs through data and product sales since, historically, the market development programs of Federal agencies have been unsuccessful.

These options will be carefully examined by the Administration over the next several months to determine which alternative best serves Federal, state and local government and private sector interests.

B. Factors affecting industry's decisions on investment

Private sector representatives tentatively have identified a number of factors that will have a strong influence on the willingness of private individuals and organizations to invest in land remote sensing satellite operations. This section reviews these factors and some initial Federal responses. Inevitably, the Federal government, in considering the national interest, may not give a private operator all of the advantages it might want.

The information with respect to these concerns comes from discussions with industry representatives. In a June 1979 report, an interagency task force led by the Department of Commerce and NASA reported on the results of its discussions with fifty people in aerospace, financial, and other companies on the issues, opportunities and options for private sector investment. NOAA discussed the issues raised in this report individually with companies known to have given additional thought to the investment questions since the June 1979 report and at two investment workshops convened in April, 1980. While the private sector does not speak with a single voice, the issues discussed below were considered important to many, if not all, of the companies.

1. Control over data and standard data products.—Fees for data and standard data products, including revenues from foreign ground stations, represent the primary source of income for the private operator, other than some form of government data purchase guarantee. Reproduction or resale of standard data products by a user without additional payments could reduce the revenue of the private system operator and make the system less viable financially. Three areas are of major concern:

Data or standard data products purchased by a private organization or a government agency may be reproduced for use in-house;

Data or standard data products purchased by a user may be reproduced or resold for use by other users; and

Data or standard data products purchased by a Federal agency may have to be provided at private requests under the Freedom of Information Act (FOIA) at the cost of reproduction.

To address these concerns the Federal government would probably have to enact legislation to enable the system owner-operator to own the data and standard data products and condition their dissemination on the payment of appropriate fees. The protections of the United States copyright laws would apply for a private owner and purchasers would not be able legally to reproduce or resell the data or standard data products without permission or payment of royalties to the copyright owner. Reproduction by foreign purchasers would be governed by international copyright agreements. The system operator could require all users to sign a sales agreement at the time of purchase prohibiting unauthorized resale or reproduction, and similar protection could be incorporated in the agreement with the operators of the foreign ground stations.

Under the FOIA, Federal agencies may be required or allowed to produce or reproduce the data or standard data products for external users at the cost of reproduction. Legislation limiting this authority and providing for the exemption of land remote sensing satellite data and standard data products from the "cost of reproduction" pricing provision of the FOIA is one way to resolve this concern.

Finally, the value of copyright protection may be significantly diluted if minor modifications to the format of the data or standard data products would free the derived product from the reproduction prohibition. If additional study indicates that legislation is required to preserve the value of the original copyright, it could be sought.

2. Equal access to data and consistent pricing policies.—Present U.S. policy requires nondiscriminatory availability of land remote sensing satellite data and consistent pricing policies applicable to both foreign and domestic users. The information extracted from certain data can have a particularly high economic value when it is used, for example, in commodities trading and in mineral exploration activities, particularly if it is not generally available. Some users would therefore be willing to pay a premium for privileged access.

While the practices of public nondiscriminatory availability of data and consistent prices may discourage some investors, they represent a carefully considered U.S. policy and no recommendation for change is made.

3. Cost recovery through data sales.—A primary concern for a potential private operator is the large gap between present system revenues and system costs. Opportunities for data ownership, Federal financial assistance and sales of data to the Federal government, in addition to implementation of a realistic pricing program (see Chapter V) and a market expansion program (see Chapter VIII) will be important elements in establishing private sector confidence in the future profitability of land remote sensing satellite activities.

4. Federal regulation.—Federal regulation of a private operator of the land remote sensing satellite system will be necessary to some extent because of threaty obligations and national security interests, in addition to the national and foreign policy considerations discussed below in Section D. Regulation should be kept to the minimum required to implement these obligations. Regulatory policy for the Fully Operational System should be established well in advance of the private operator's assumption of responsibility for the system, and to the maximum extent possible remain constant for the useful life of the system.

5. Competition with data from Federal R. & D. systems.—The concern has been expressed that data freely available from Federal R. & D. land remote sensing satellite systems will compete with the data from the private operations system, reducing private system revenues. NASA probably will continue, however, to develop some advanced experimental sensors and spacecraft systems for land remote sensing because:

National policy requires maintenance of U.S. technlogical leadership, a function assigned to NASA under the 1958 Space Act, to be in a favorable competitive position with respect to foreign systems; and

High costs and high risks are associated with these developmental systems, and experience in the satellite communications arena indicates that the private sector may not fund R&D activities to the extent necessary to maintain national leadership.

Since NASA currently is required by its enabling statute to ensure the widest practicable and appropriate dissemination of information concerning its activities and the results thereof, one solution could be to establish procedures under which the private operator would distribute NASA's experimental land remote sensing satellite data to potential users other than those directly engaged in programs in cooperation with NASA. Fees compatible with those from the Fully Operational System could be charged for the experimental data. In addition, NASA could limit its R&D in land remote sensor technology to those areas where the most advanced technological efforts are involved.

6. Federal competition in services.—Federal agencies prepare information products derived from standard data products provided by the system operator to meet the needs of the agencies and their constituents. Such activities present two potential problems to the private sector: In-house preparation of information products could hamper transfer of the resulting technology to non-Federal users and the value added service industry, and distribution of information products by Federal agencies could preclude development of markets for similar private sector information extraction services, thus reducing the consumer market available to the value-added service industry.

Although transfer of technology to non-federal users is essential if the full range of benefits to the nation from the operational land remote sensing satellite system is to be achieved and private sector investment is to be encouraged, some agencies have missions that require them to produce information products for constituent groups. Land remote sensing satellite data are often only one of many inputs into these products. Thus, the in-house production of derived information products for governmental purposes should not be prohibited, but should not compete with the private sector where at all possible.

Federal agencies already are required to use private sector services whenever the private sector can provide them rather than compete with it. OMB Circular A-76, "Policies for Acquiring Commercial or Industrial Products and Services Needed by the Government", reaffirms the Federal government's general policy of reliance on

the private sector for goods and services, while recognizing that governmental functions must be performed by government personnel. This Circular establishes the policy that the Federal government should not be in competition with the private sector where the capacity exists to meet Federal needs. As private sector capabilities in the field of land remote sensing satellite data analysis and information extraction expand, Federal and non-Federal users can be encouraged to locate and make use of these commercial capabilities.

7. Federal Government's role in technique development and training.—Federal agencies conduct certain large, high-cost demonstration projects, such as LACIE and AgRISTARS, to meet their needs. However, these programs often are conducted by government personnel using government facilities. Consequently, they may not contribute directly to the development of the value added services industry and to the expansion of its capability to deliver these new services to other potential users.

Major portions of the federally funded training programs now are conducted at government centers through workshops, "hands-on" training programs, and other activities under the technology transfer programs. Little use is now made of the training and demonstration capabilities of the not-for-profit or value added services companies in these Federal programs to train users in Federal, state and local governments, industrial concerns and foreign organizations.

The Federal policy expressed in OMB Circular A–76 applies to demonstration and training programs and provides that, if cheaper, they should be performed under contract by the private sector. As discussed in Chapter VII, A–76 analyses can be used to determine if private sector provision of these services is cost effective. If so, Federal agencies should contract with private firms to provide demonstration and training programs on a reimbursable basis, for a wide range of users.

8. Coordination with foreign satellite operators.—Present U.S. civil space policy requires that the U.S. promote development of complementary nationally-operated satellite systems so as to increase benefits for all nations. Industry representatives share this view that duplication in spacecraft and ground systems should be avoided whenever possible. Potential private system operators are concerned, however, that this policy may preclude the development of U.S. satellite systems which could provide high market value standard data products, such as stereoscopic data, similar to those produced by foreign systems.

Foreign land remote sensing satellite systems have both competitive and cooperative aspects. The prospects for competition and cooperation with foreign land remote sensing satellite operators are discussed in Chapter VIII.

A related industry concern is that the U.S. system would be in competition with foreign owned systems that may be assisted financially by their governments, putting the U.S. industry at a competitive disadvantage unless the U.S. operation is similarly treated. Since financial assistance in some form may be needed until a reasonable return on investment can be realized by a private operator, the impact of possible foreign government assistance to foreign systems should be addressed in that context.

9. Long-term Government financial commitments.—The Federal government is currently the major user of land remote sensing satellite data and standard data is products and is likely to continue to be a major user, at least during the 1980s. As discussed in Chapter V, the extent to which the Federal government is willing and able to provide financial assistance to the operator of the land remote sensing satellite system may be a key factor in the private sector's decision to invest. Of concern to industry is the duration and binding nature of any Federal commitments.

The private sector wants to avoid making substantial initial capital investments in spacecraft and ground facilities only to find that changed policies or economic conditions have eliminated the anticipated revenues from Federal data purchases or assistance.

C. Policies to involve the private sector during Federal ownership of the interim system

During NOAA's management of the operational system, substantial efforts should be made to encourage private sector investment through:

(1) Expanding opportunities for the value-added service industry by: Encouraging large users of data products to arrange for their own special processing capability; Assisting customers in occasional need of special processing to locate appropriate capability in the private sector; and Providing only two types of special services, for which extra fees will be charged: (a) special tasking of the satellite to provide data on areas not in the archives and not normally observed in routine operations, and (b) accelerated preparation of standard products when the need for data is urgent.

(2) Use of the private sector to the fullest extent possible to conduct market expansion activities described in Chapter VII below.

(3) Contracting with private corporations to operate all or part of the operational system on terms that allow a fair rate of return. Such contracts might include supplying retroactive data or operating all or a part of the ground system under general NOAA supervision.

D. Regulation of private sector operation

When NOAA's responsibilities as the system operator are transferred to another entity, the implementation of international obligations, adherence to national policies and achievement of national goals will require a continuing Federal regulation of land remote sensing satellite activities that extends beyond the Federal government's concerns as a user of data and standard data products.*

1. Federal policies applicable to the civil land remote sensing satellite system.—The necessary Federal regulatory framework must be established in any legislation authorizing private sector ownership and operation of our civil operational land remote sensing satellite activities. The following are the major policy areas expected to require regulation:

a. Compliance With Treaties

The United States is a party to several treaties and agreements that apply to the space activities of the civil operational land remote sensing satellite program. The principal treaties and agreements are (1) the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the Outer Space Treaty), (2) the Convention on International Liability for Damage Caused by Space Objects, (3) the Convention on Registration of Objects Launched into Outer Space, and (4) treaties and agreements reached in the International Telecommunications Union.

The Outer Space Treaty stipulates in Article VI that States bear international responsibility for outer space activities whether carried on by governmental agencies or non-governmental entities, and for assuring that such activities are carried out in conformity with the Treaty's principles in support of the use of outer space for peaceful purposes and for the benefit of all peoples irrespective of the degree of their economic or scientific development.

The Liability Convention and the Registration Convention implement the broad principles of the Outer Space Treaty by requiring, respectively, (a) that each State which launches a space object be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight, and (b) that each launching State register with the Secretary-General of the United Nations information identifying the space objects, launching State, registration number, date and location of launch, basic orbital parameters and general function. The International Telecommunications Union, a UN Organization, controls the allocation of the radio frequency spectrum to satellite services throughout the world.

b. National Space Policy Considerations

In addition, U.S. civil space policies that reflect significant national interests should be applied to the activities of nongovernmental entities in enabling legislation or implementing regulations. These policies require, among other things: The widest practicable dissemination of data and results from civil space programs, except where specific exceptions are established by legislation, Executive Order, or directive; The monitoring and, if necessary, control of technological advances and capabilities in accordance with national policies; General support of nondiscriminatory direct readout to foreign ground stations under specific conditions; Pricing policies that are consistent with respect to foreign and domestic users, and Pursuit of complementarity with foreign-operated satellite systems so as to limit U.S. program costs, but protect against unwarranted technology transfer.

c. Provision of Adequate Data for Governmental Use

National policy should establish that a private owner of our civil operational land remote sensing satellite system be required to meet the data requirements of government users because of the importance of this data to the missions of Federal agencies and the responsibilities of state and local governments, many of which derive from Federal statutes.

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*In May 1978, the President called for supervision and regulation of any private sector entity's space activities to ensure, inter alia, that advances in land remote sensing from space will be permitted under controls and when such needs are justified and assessed in relation to civil benefits, national security and foreign policy.

d. Improper Use of Inside Information

When the system is transferred to the private sector, private investors and corporations will have control over the land remote sensing satellite system and the initial data stream. This data, as discussed above, can be particularly valuable to anyone who has exclusive rights or advance access to it. Continued implementation of existing policy for equal access to the data and standard data products is recommended. In addition, appropriate steps must be taken to ensure that the data is not improperly used for the financial advantage of a private owner, investor or corporate board member. In addition to direct legislative prohibitions of these abuses, prohibitions or restrictions on stock ownership or board membership by those with potentially conflicting obligations or interests may be necessary.

e. Preservation of Competition and Pricing Policies

Another important public policy, expressed in the Federal antitrust laws, is the preservation and promotion of a free competitive economy. Although Federal governmental action may grant an exclusive license or give a statutory monopoloy to a private operator, the operator's pricing policies, procurement, data production and dissemination policies should not be allowed to restrain competition beyond the scope of the government grant. For instance, Federal regulation should insure that the private operator's procurement of major facilities, such as satellites or ground stations, is accomplished by competitive bidding, and that small and minority businesses are given an opportunity to compete. All users should have nondiscriminatory use of and equitable access to the data and standard data products generated by the System. The Federal government should regulate the operator's pricing policies to prevent abuse of its monopoly position. The fees charged by a private operator should provide a reasonable rate of return and be structured to avoid discrimination or undue preference to any class of users.

2. Selection of lead regulatory agency.—An agency must be identified to take the primary responsibility for the regulation of the private operator. This designation should be timed so that appropriate administrative arrangements can be established and any necessary regulations can be adopted before the transfer of system operation to the private operator.

As part of its on-going management responsibilities, NOAA should assume primary responsibility for the implementation of this Federal regulatory role, with other agencies maintaining specific regulatory roles in areas of their particular responsibility, such as the foreign and antitrust aspects of the System.

Chapter VII

MARKET EXPANSION

Land remote sensing data obtained from spacecraft have been used to help meet user decisionmaking needs for only a few years, often on a limited, trial basis. If the system is to pay for itself and be transferred to the private sector, strong efforts must be initiated to stimulate new uses of the data products and to evaluate the domestic and foreign markets that develop.

This chapter briefly states the prerequisite for a market expansion and evaluation program, summarizes efforts to date to develop uses for Landsat data and standard data products, and suggests actions that could be taken to ensure an aggressive program of market growth and evaluation during the 1980s.

A. Prerequisite for a market expansion program

As noted in Chapter II, continuity of land remote sensing data is a prerequisite to the increased use of land remote sensing satellite data. Users will not rely on satellite data until its continuity, with adequate reliability and timeliness are assured. Only then can users confidently invest in the personnel, training and processing equipment necessary to utilize the data and standard data products in their operational programs. Without these assurances, growth in the utilization of the data will be limited and any new efforts at market expansion might be inappropriate and unsuccessful.

B. Current market expansion activities

Within the Federal government, the primary responsibility for market expansion activities for Landsat data and standard data products has been shared by NASA and the EROS Data Center (EDC) of the Department of the Interior.

NASA, in addition to providing Landsat data from the R&D program, has been engaged in substantial technique development and test programs made up of several components:

The Application Systems Verification and Transfer Program, consisting of over 20 large scale feasibility projects directed at testing, demonstrating, and transferring Landsat applications in representative operational settings, with the direct participation of user organizations. These projects serve as detailed prototypes for large, relatively homogeneous user markets and provide a major stimulus for more widespread use of the demonstrated application.

The Regional Remote Sensing Applications Program, through NASA's three regional centers, is conducting a national scale technology demonstration and training effort to develop capabilities within the states to apply Landsat data to their every day resource management problems. State-wide programs have been undertaken in approximately 30 states, and more than 1500 state agency personnel have been trained.

The University Applications Program, designed to build university capabilities for the conduct of research, education, and public service activities supporting the transfer of Landsat technology, primarily to state and local governments. In addition to developing recognized centers of expertise in Landsat applications, the University Applications Program serves to stimulate the development of basic specialized remote sensing courses in the university curriculum and the creation of the body of trained people that are critical to any successful long-term technology transfer program. Over 25 such university programs have been established.

About 160 Federal and contractor support personnel are engaged in these efforts. The NASA fiscal year 1980 budget for these programs totals $10 million.

The EROS Data Center also has played an active role in the development of user capability. It has: Conducted about 20 seminars per year, primarily for Interior personnel, which also serve as the primary medium of training for students sponsored by other government agencies, state governments, and foreign organizations; sponsored approximately 30 cooperative projects, primarily for DOI investigators, with six more planned for FY 1980; and encouraged curriculum development for post graduate studies, primarily at the University of Michigan, Harvard University, and the University of California.

About 10 Federal contractor support personnel and $1.0 million were devoted to training and technology transfer activities in fiscal year 1980.

Other Federal agencies have focused primarily on the development of users within their own organizations. To date, USDA, the U.S. Army Corps of Engineers, and the Department of Commerce, through the Census Bureau and NOAA, have been most active in this regard. The Agency for International Development has conducted a grant program designed to increase Landsat technology awareness in developing countries and has supported the establishment of regional training and user assistance centers in Africa and Asia.

The private sector has been involved in the development and sale of devices for visual interpretation and computer analysis of remote sensing data, the provision of processing and analysis services that add value to the data products, and contract support to NASA and the EROS Data Center in data dissemination and the transfer of remote sensing technology. In addition, some 178 colleges, universities, and nonprofit organizations are providing instruction in remote sensing or photogrammetry. A number of professional societies conduct symposia designed to inform their members about scientific and technical developments and operational applications of land remote sensing from space.

Several international organizations have been active in helping foreign, users of Landsat data. The United Nations and some of its specialized agencies have sponsored training programs and are helping to develop Landsat data analysis programs in developing countries. The Inter-American Development Bank makes loans for development projects using Landsat data and has funded training programs for Latin American users. Similarly, the World Bank makes loans for Landsat analysis activities in connection with development projects in Africa and Asia. Finally, certain foreign countries—among them Canada, Japan, the Federal Republic of Germany, France, and Italy—utilize Landsat data and related analyses in connection with their own foreign assistance programs.

C. Some suggestions for a market expansion program

In order to expand the beneficial use of land remote sensing satellite data and thereby enhance the market for system products two factors should be considered: tailoring the system to user needs, and helping users benefit from the products. Ways to implement these objectives are suggested below:

1. Tailoring the system.—Continuing attention to user requirements through market surveys and other studies is essential for the system to be refined and for detection of new markets as they emerge and develop. Particular study of the user requirements of local governments, the private sector, international organizations,

and foreign nations is necessary, since these market areas are so far the least well understood.

By its compilation of preliminary user requirements, NOAA has already initiated a significant step in marketing the system to user needs over the long term. These preliminary user requirements will play a key role in determining the characteristics of the Fully Operational System. Other actions that could be taken in order to validate these requirements are: Developing standard data products which will be made available over for long periods of time, e.g., data in the MSS format; adding new data products designed to satisfy most nearly the requirements of all users; and evaluating systematically the response of users to the products of the Interim Operational System in order to refine the practices being followed and to shape the characteristics to be offered by Fully Operational System.

2. Helping users benefit from the products.—The three main categories of assistance to users are training, the development of new techniques and applications, and the demonstration of existing and new applications in the users' operations. For all three, user participation and investment are important factors in realizing the benefits of the new technology embodied in satellite remote sensing. This can be encouraged by NOAA's undertaking joint ventures in working with users, wherever that is possible.

a. Training

The Department of the Interior has developed successful training equipment and course materials in support of departmental interests, as have other major Federal government users. Major Federal users can be encouraged to arrange for specialized or on-the-job training for their employees to enhance their successful utilization of land remote sensing data. In addition, NOAA could arrange through the private sector for general training on a reimbursable basis for Federal, state, and local government personnel and for foreign students. Specialized training programs can be arranged whenever sufficient demand arises. NOAA also could assist universities and private sector organizations in developing course materials to be used in training students from the private sector.

b. Applications Development

NASA probably will continue to develop and share with users technology and techniques for acquiring, processing, and interpreting land remote sensing satellite data as part of its basic responsibility for R&D in space-related technology. NASA also could continue testing new techniques and potential new applications in joint projects with users in all sectors. As part of this program, NASA could undertake the development of a broad array of information extraction procedures aimed at specific applications.

The NASA budget devoted to continuing its program of remote sensing technology transfer and applications testing is approximately $5.7 million for FY 1981.

c. Applications Demonstration

A series of joint demonstration projects with users in all sectors, including other Federal agencies and state and local governments, could enhance the market for land remote sensing satellite data. As part of such a program NOAA could: Work with the major Federal user agencies to help them expand their development of new applications of the data; demonstrate the utility of land remote sensing data in meeting Federal requirements for information imposed on state and local governments; explore the uses of government extension programs such as the USDA county agent system, to reach potential users throughout the country; and assist the Agency for International Development and other organizations in demonstrations to foreign users.

In these joint demonstrations, private sector firms could be used so that they can repeat the demonstrations with additional potential users after each joint demonstration project is successfully completed.

3. Other actions.—More general support to develop the field of land remote sensing from space could be provided in the following ways: Information dissemination activities could be conducted to develop public awareness of the potential benefits of land remote sensing satellite data; university centers of excellence could be supported and universities could be assisted in developing research and instructional capabilities in the use of land remote sensing satellite data so as to expand the cadre to trained professionals; the Small Business Administration and the Economic Development Administration could be involved in assisting new entrepreneurs in entering the land remote sensing satellite field; and the International Development Cooperation Agency, the Intertnational Trade Administration, the Overseas Private Investment Corporation, and the Export-Import Bank could assist in expanding opportunities abroad for U.S. vendors of land remote sensing equipment and services.

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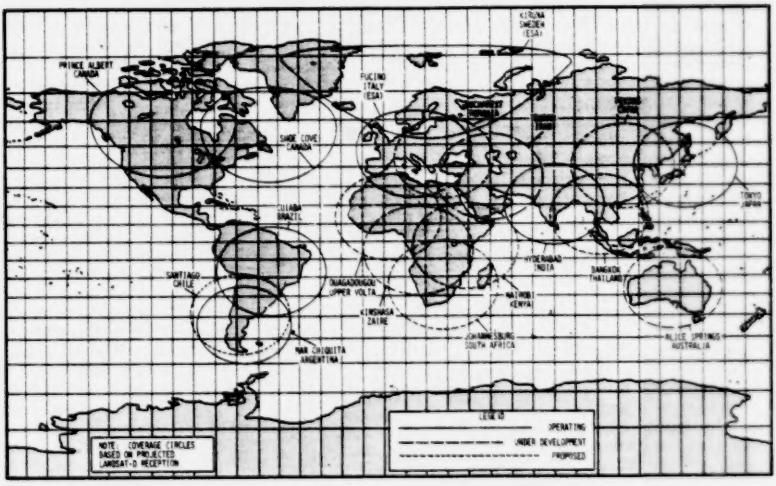
TABLE VIII-1
FOREIGN LANDSAT GROUND STATION COVERAGE



LANDSAT GROUND STATION STATUS

Country	Agreement Signed	Data Reception	Data Processing
Argentina	1976	1980	1980
Australia	1979	1980	1980
Brazil	1973	1973	1974
Canada			
Prince Albert	1972	1972	1972
Shoe Cove	1976	1977	1977
Chile*	1975	TBD	TBD
China	1980	TBD	TBD
India	1978	1979	1980
Iran*	1974	TBD	TBD
Italy (ESA)	1974	1975	1976
Japan	1979	1979	1979
Sweden (ESA)	1978	1978	1979
Thailand	1979	TBD	TBD
Zaire*	1975	TBD	TBD

Other countries contemplating Landsat Stations: Kenya, New Zealand, Romania, South Africa, and Upper Volta

*Note: Chile and Zaire have thus far been unable to fund the establishment of their proposed Landsat stations. The Landsat station in Iran was largely completed and began receiving some test data in late 1978. However, the station ceased operations in early 1979 as a result of the political situation in Iran.

TBD = To Be Determined

CHAPTER VIII

INTERNATIONAL ASPECTS

The U.S. land remote sensing satellite program has included significant international participation since its inception. This chapter reviews the history and current objectives of this participation and discusses relationships with foreign data users and with operators of foreign land remote sensing satellite systems.

A. History and objectives

International participation in the U.S. experimental land remote sensing program was stimulated by U.S. efforts in the late 1960s and early 1970s to acquaint potentially interested countries and international organizations with NASA's plans for the development of land remote sensing satellites and their prospective benefits. As a result, investigators from some 50 countries took part in three NASA research programs designed to assess the usefulness of land remote sensing satellite data. In addition, agencies in thirteen foreign countries made arrangements with NASA for direct reception of data from the current experimental Landsat satellites. Table VIII-1 lists the status and depicts the coverage of the foreign receiving stations currently operating as well as those being planned. These foreign Landsat stations operate under agreements concluded between NASA and a cooperating foreign government agency which provide for: (a) foreign agency funding and operation of the ground station, (b) public availability of all Landsat data acquired by the station, (c) support for and (d) the payment to NASA of an annual access fee (currently set at $200,000 per station per year).

The U.S. should continue to ensure international participation in the Interim and Fully Operational Systems under arrangements that contribute to the objectives of: Fostering international receptivity to and acceptance of U.S. space remote sensing activities;

developing a world-wide market for U.S. commercial data products and associated hardware and services; enhancing the technical quality and scope and reducing the cost of the U.S. land remote sensing satellite program; encouraging utilization of land remote sensing satellite data and techniques in the national and regional development programs of developing nations; and maintaining U.S. commercial and technological leadership in the field of space remote sensing.

In pursuing these objectives, the U.S. should concentrate its efforts on the further development of an international community of data users and on the establishment of constructive relationships with those foreign countries also planning to operate land remote sensing satellite systems.

B. Relationships with foreign users

Since the first experimental Landsat was launched in 1972, foreign use of Landsat data has grown steadily. This trend is evident in the growing list of countries establishing Landsat stations (see Table VIII-1) and in the data sales statistics of the EROS Data Center, which currently receives 36 percent of its sales revenues from users with foreign addresses. A further indication of this trend and the long term foreign market potential for land remote sensing techniques by national and international development assistance organizations. The Agency for International Development, for example, has worked closely with its counterparts in Canada and France to help the African countries establish three regional training and user assistance centers which are making extensive use of Landsat data. The World Bank, the Inter-American Development Bank and a number of U.N. entities such as the Food and Agriculture Organization and the U.N. Development Program are increasingly using Landsat Data in support of national development projects. These activities are likely to continue to expand and, as they do, so too will the demand for land remote sensing satellite data.

Availability of data to foreign users.—In recognition of the growing international demand for land remote sensing data, the U.S., should continue to provide for the availability of data from the Interim and Fully Operational Systems through: Direct readout of data to foreign ground stations. This will carry forward the long-standing U.S. practice of permitting direct foreign reception of data from U.S. civil Landsat satellites; and public nondiscriminatory availability of data from one or more U.S. distribution facilities. This practice will assure foreign users access to data acquired outside the coverage zones of foreign ground stations and give them the option of

obtaining data either from a foreign-operated ground station or from the U.S. via mail or communications satellites.[1]

Under current U.S. civil space policy, the U.S. generally supports direct readout of data from the Interim and Fully Operational Systems; however, if a special purpose remote sensing mission were undertaken, such as the Sterosat mission currently being discussed by a number of U.S. Government and private users, the U.S. could make a separate, specific determination of whether and under what conditions direct readout would be available.

In connection with these U.S. data distribution plans, NOAA, along with other interested U.S. agencies, should participate in the discussions of the United Nations Committee on the Peaceful Uses of Outer Space concerning land remote sensing satellite data acquisition and dissemination. These U.N. Committee discussions, which began in the early 1970's, have included consideration of a draft set of legal principles to guide such remote sensing activities. A key question concerning these principles is whether they should embody restrictions on dissemination of data. Some countries have expressed the view that dissemination of data without the consent of the sensed country would constitute infringement of a sensed nation's sovereignty. A number of countries are also arguing that the principles should embody priority access to both data and derived information relating to their territory.

In the U.S. view, no legal justification exists for contending that the principle of national sovereignty over resources should be extended to include control over data or derived information relating to those resources. The U.S. considers that public nondiscriminatory dissemination of space remote sensing data does not require the consent of the sensed state. On the contrary, the U.S. view is that such public nondiscriminatory dissemination of data is fully consistent with obligation in the Outer Space Treaty requiring satellite-operating nations to share the benefits of space use as widely as possible and is the most practical and effective way to adhere to this obligation.

2. *Pricing policies—international considerations.*—Pricing policies that are developed for the Interim and Fully Operationsal Systems for users sharing of the costs of acquiring and processing data will apply to foreign and domestic users through sales of standard data products and through fees for the reception by foreign ground stations of data transmitted directly from the satellites. As these pricing policies are developed, the following factors will be considered in light of their potential impact on foreign users: Development of consistent pricing policies for domestic and foreign users alike; phasing of price increases to encourage continued growth in the demand for land remote satellite sensing data; and adequate lead time for price increases so that foreign station operators can be consulted and so station operators and their user communities can arrange for funding of the added data costs.

As NOAA develops policies for sharing the cost of acquiring and processing land remote sensing data, several other considerations will be taken into account. One of these is the concern of many foreign users that future cost-sharing arrangements may result in prices which are so high as to inhibit the widespread use of land remote sensing data. Another consideration is the possibility that future U.S. data sales prices—set to achieve a reasonable amount of cost-sharing—will be undercut by the prices established by foreign satellite system operators. NOAA will recognize and weigh these considerations as it shapes a realistic and viable pricing structure that encourages the development of a world-wide market for land remote sensing satellite data and helps reduce U.S. expenditures for the Interim and Fully Operational Systems.

3. Next steps.—As plans for the Interim and Fully Operational Systems are undertaken, NOAA, working closely with the Departments of State, NASA, AID and other interested U.S. agencies, should: Consider foreign user requirements—particularly those of developing country users—in planning the Fully Operational System. One step in this direction should be the holding of informal regional meetings to determine user data requirements within the various regions. At these meetings, representatives from the U.S. and other countries operating satellite programs could discuss their respective plans and learn the data requirements of foreign users; conclude agreements with those foreign agencies wishing to receive data directly from the Interim and Fully Operational Systems at foreign Landsat-type ground stations. These agreements should establish conditions for direct reception which will support the international participation objectives listed above; establish pricing

[1] Communications satellites offer the prospect of relaying data in near real time from distribution centers to users. Though the current cost of such service is high, it may become a viable alternative to direct readout in the next decade should be taken into account as plans for the Fully Operational System are developed.

policies for direct reception and U.S. sale of land remote sensing data that take into account the considerations noted above; and continue the NASA-established Landsat Ground Station Operations Working Group which consists of those foreign agencies operating or planning to operate Landsat ground stations and which provdes a useful forum for the exchange of technical information and experience.

C. Relationships with foreign satellite operators

As discussed in Chapter I, the European Space Agency, France, India, Japan and the Soviet Union have initiated land remote sensing satellite programs. A number of these foreign programs (which are outlined in Table VIII-2) offer the prospect of both competition and cooperation with the U.S. program.

1. *Foreign competition.*—The potential competitive impact of planned foreign land remote sensing satellites is a subject of considerable significance to the U.S. as it pursues plans for the Interim and Fully Operational System. This competitive challenge to U.S. land remote sensing satellite program leadership occurs in several areas:

Sensor Technology Development: France, Japan and the European Space Agency are developing multilinear array sensor systems for use on their land remote sensing satellites. The French multilinear array is scheduled to fly on SPOT in 1984, and the Japanese multilinear array will fly on an ocean observations mission in 1985. NASA is planning an experimental multilinear array sensor, which could be tested on the Space Shuttle in the mid-1980s. A U.S. operational multilinear array sensor could probably not be available for U.S. use before 1989 at the earliest.

Ground Equipment and Services: Though the market for Landsat-type ground station equipment is quite limited, the prospects for sales of equipment, software and services associated with analyzing land remote sensing satellite data are considerable. Other countries are well aware of these prospects and are likely to compete extensively with the U.S. in these markets.

Data Sales: Foreign land remote sensing satellite systems undoubtedly will have an impact on the world-wide market for data products. The degree to which foreign data sales would penetrate this market and consequently have an adverse impact on the U.S. market share would depend on the U.S. commitment to produce superior data and standard data products.

2. *Complementarity with foreign satellite systems.*—While competition undoubtedly will exist between U.S. and foreign land remote sensing satellite systems during the next two decades, their development also offers prospects for cooperation.

Drawing on its considerable experience in the coordination and harmonization of foreign operated geostationary meteorological satellites, NOAA (working closely with NASA, the Department of State and other interested U.S. agencies) is initiating discussions with prospective foreign land satellite system operators with a view toward encouraging complementarity and compatibility among future operational land satellite systems. These discussions will focus on prospects for:

Complementary system characteristics, such as spacecraft orbits; coverage patterns, and repeat cycles; and types of sensor systems.

Compatible system outputs, such as common spacecraft downlink frequencies; standard data product formats; and standard data cataloging and archiving procedures to facilitate data exchanges.

The U.S. objectives in these discussions (in addition to the overall Objectives listed at the beginning of this Chapter) include:

Maximizing the potential usefulness of U.S. and foreign land remote sensing satellite data for U.S. users as well as users in other countries; minimizing the duplicative aspects of foreign satellites by encouraging the development of foreign capabilities that complement U.S. programs; and limiting U.S. space segment costs by avoiding unnecessary expenditures for missions that will be undertaken by other countries, so long as this does not result in undesirable U.S. dependence on foreign space capabilities.

3. *Next steps.*—With respect to the development of foreign land remote sensing satellite systems, NOAA, working closely with other interested U.S. agencies, should:

Encourage the expension of world-wide markets for U.S. equipment, services and data products. This is important for maintaining U.S. leadership in the land remote sensing satellite field.

Conduct discussions with other satellite operators. Several preliminary consultations with prospective land remote sensing satellite system operators have already taken place, the most recent of which was a meeting involving Canada, the European Space Agency, France, India and Japan that took place in Ottawa, May 8-9, 1980. This meeting resulted in a decision to create an informal, technical consultative group which will be comprised of the program managers from those countries that are in the process of establishing land remote sensing satellite systems that

may move into an operational phase. This group is intended to provide a forum for close coordination and harmonization of U.S. and foreign land remote sensing satellite program plans.

TABLE VIII-2

DEDICATED FOREIGN LAND SATELLITE MISSIONS

MISSION	LAUNCH DATE	SPONSOR	OBJECTIVES	PROGRAM STATUS	SENSORS	ORBITAL PARAMETERS	DATA HANDLING
SPOT-1 (System Probatoire d'Observation de la Terre)	1984	France (Centre National d'Etudes Spatiale)	Develop satellite reusable and non-reusable earth resource observations technologies. Develop a stereo and cartographic data archive. Test possible configurations for a future operational system.	Funded	Two 3-channel multispectral pushbroom visible spectrum multilinear array sensors	832 km Sun synchronous 26-day repeat cycle (providing capability per-mits 1 to 5-day time-apart repeat)	Direct-readout to foreign ground stations. 2 on-board recorders
LOS-1 (Land Observation Satellite)	1987	Japan (Science and Technology Agency/ National Space Development Agency)	Develop capability for agricultural, land use, geological and water resources observations. Test usefulness of data for disaster, coastal and harbor observations.	Mission definition studies funded	4 channel visible and near infrared multilinear array. 4 channel visible and thermal infrared mechanical scanner. Additional sensors under study.	Approximately 568 km Sun synchronous 14 17 day repeat cycle	Direct-readout to foreign ground stations planned
LASS (Land Application Satellite System)	Late 1987/ early 1988	European Space Agency	Develop space observations techniques for agricultural, land use and water resources monitoring.	Mission definition studies funded	5 channel multispectral visible spectrum multilinear array. 7 channel mid and near infrared multilinear array. 9 3 GHz radiometer spectrum cells	675 km (baseline orbit) Sun synchronous 17 day repeat cycle (baseline orbit)	Direct-readout to foreign ground stations planned. No on-board recorders planned
IRS (Indian Remote Sensing Satellite)	To be determined	India (Indian Space Research Organization)	Develop space observations system for monitoring agriculture, water resources, forestry, coastal areas, and geological features.	Under study	To be determined	Sun synchronous	To be determined
LOS-2 (Land Observation Satellite)	To be determined	Japan (Science and Technology Agency/ National Space Development Agency)	Develop capability for agricultural, land use, geological and water resources observations. Test usefulness of data for disaster, coastal and harbor observations.	Under study	4 channel visible and near infrared multilinear array. 4 channel visible and thermal infrared mechanical scanner. Additional sensors under study.	Approximately 568 km Sun synchronous 14 17 day repeat cycle	Direct-readout to foreign ground stations planned
MOS-1(1) (Marine and Earth Resources Evaluation Satellite)	To be determined	Japan (Ministry of International Trade and Industry/ National Space Development Agency)	Develop techniques for satellite observations of non-renewable resources.	Under study	To be determined	To be determined	To be determined

CHAPTER IX

ADDITIONAL LEGAL AUTHORITY

As part of developing the Administration's fiscal year 1982 legislative program, the Administration is examining areas where legislation may be needed to implement the civil operational land remote sensing satellite program. Likely areas for additional legislation are:

To establish and protect the property interests in the data and standard data products produced by the operator of the land remote sensing satellite system; to provide NOAA the authority to develop, own and operate the U.S. civil operational land remote sensing satellite system until the responsibility is transferred to another entity; to establish and specify the institutional framework, and authorize appropriate financial assistance, for eventual private sector ownership and operation of the civil operational land remote sensing satellite system; and to authorize NOAA to regulate the activities of, and to coordinate Federal user relationships with, any commercial operator of all or any part of the U.S. operational land remote sensing satellite system.

The Administration plans to introduce the required legislation in the 97th Congress.

A. Proprietary interests in satellite data and products

The data and standard data products produced by the experimental Landsat program have been disseminated widely through a decentralized distribution system at prices that reflect the cost of reproduction or at no cost. The data itself is in the public domain, free of any of the controls associated with copyright or ownership.

To accomplish the objectives that users share in the costs of the system and that the private sector should eventually own and operate the U.S. civil operational land remote sensing satellite system, this approach to data dissemination may need to be changed, as discussed in Chapter VI, Section B.1. The system operator may require the authority to establish ownership rights in the data and to condition subsequent reproduction and distribution of the data and standard data products on payment of a fee, either directly or through higher direct reception fees, so it can assure effective application of any schedule of fees that exceeds the cost of reproduction. Otherwise secondary distribution at prices below those charged by the system operator but above the cost of reproduction could undercut the system operator's market.

This control would have to be limited so as to require any system operator or foreign ground station operator to comply with the Federal policy of widest practical dissemination of data and standard data products on a public nondiscriminatory basis.

The parameters for authorizing ownership and proprietary controls of land remote sensing data and standard data products are still under review and will be outlined in an Administration bill authorizing the operational system.

B. NOAA enabling legislation

Since no clear legislative mandate exists for any Federal agency to develop, own and manage a civil operational land remote sensing satellite system, legislation authorizing the Department of Commerce to develop, own and operate the Interim and eventual Fully Operational Systems, until such time as this responsibility is transferred to some other entity, will be required to succeed the one-year authorizing legislation that was introduced in the Congress earlier this year.

This legislation can authorize the Secretary of Commerce, inter alia, to:

Develop, own and operate U.S. civil operational land remote sensing satellite systems, including the functions of procuring and operating the satellites, and preprocessing, processing, archiving and disseminating the data and standard data products; conduct applications demonstration and training programs; and engage in a program of international cooperation under the foreign policy guidance of the President and working closely with the Department of State, NASA, the International Development Cooperation Administration/Agency for International Development, and other interested U.S. agencies.

C. Institutional framework for eventual private sector operation

This document identifies several options for eventual transfer of primary responsibility for ownership and operaton of all or a part of the land remote sensing satellite program to the private sector. Until the mechanism for private sector ownership and operation becomes effective, NOAA will operate the program in order to carry out the President's commitment to continuity of data during the 1980s.

If the Federal government adopts Option 2 or 3 in Chapter VI for legislative creation of a new corporation, consideration should be given to authorizing its

establishment sufficiently in advance of its target "takeover" date so that it can play a role in the technical design and establishment of the operational system that it will manage.

Legislation that authorizes the creation of a new corporation should contain the following elements:

Powers of the corporation to develop,[1] own and operate the U.S. civil operational land remote sensing satellite system.

Composition of the Board of Directors, including the appropriate mix of Presidentially-appointed and privately-elected board members.

Authority of the corporation to issue captial stock in prescribed amounts, with voting and nonvoting rights, and debt obligations either privately or through the Federal Financing Bank.

Establishment of procedures for the corporation's internatonal business activities and for ensuring compliance with United States foreign policy.

Authorization of an appropriate combination of financial assistance mechanisms, including procedures for its administration and appropriate techniques for protecting the Federal government's financial interests.

D. Regulatory authority

The Administration's proposed legislation establishing the institutional framework for private sector operation will identify the agency or agencies responsible for regulating the activities of any private operator or operators or government corporation in accordance with international obligations and national space policies applicable to land remote satellite sensing, as set forth in Chapter VI D. above.

Such a bill would designate NOAA to regulate the activities of a private sector owner, including, but not limited to, data dissemination and pricing practices, technical standards and provision of services to Government purchasers, as described in Chapter VI D. The Federal government also will have to regulate the private entity's international business arrangements, establish the necessary agreements for direct readout to foreign ground stations, and particiapte in complementary discussions with foreign satellite operators.

GLOSSARY

Access Fee: The charge paid by operators of ground stations for the right to receive the data transmitted from land remote sensing satellites.

AgRISTARS: Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing. Large, cooperative, multi-year development program of the Departments of Agriculture, Interior, and Commerce, NASA, and AID. Will develop, test, and evaluate ways to use remotely sensed data to produce early early warnings of crop stress, crop assessments and forecasts, small area land cover and water evaluation, and renewable and nonrenewable resource inventories.

AID: Agency for International Development, United States International Development Corporation Agency.

Basic Fee: The charge paid by each user for each standard data product purchased from the U.S. system operator.

CCT's: Computer Compatible Tapes. Magnetic tapes containing digital data in appropriate format.

Core System: The space and ground segment elements necessary to meet the common needs of the majority of users.

Data: In this document, "data" is used to specify the sensor voltage readings that are transmitted in digital format and received at the ground station. These readings must be interpreted and converted to other dimensions for most applications purposes.

Direct Readout: The capability that allows ground stations to collect and interpret the data messages that are transmitted from satellites.

DOC: Department of Commerce.

DOI: Department of the Interior.

DOMSAT: Domestic Communications Satellites.

EROS: Earth Resources Observation Systems.

EROS Data Center: A facility that collects, processes, archives, and distributes data obtained from satellite, aircraft, and other systems, operated by the Geological Survey, DOI, at Sioux Falls, South Dakota.

ESA: European Space Agency.

FOIA: Freedom of Information Act.

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[1] The authority to conduct research and development may not be exclusive. As noted in Chapter VI B.5., NASA probably will continue to conduct such activity in the interest of maintaining U.S. technological leadership.

Fully Operational System: The future operational system with space and ground segments designed to meet authenticated and agreed user needs.

Frequency of Observation: The normal period, usually measured in days, elapsing between two sequential times at which a point on the Earth falls within the field of view of one of the spacecraft of the system.

GSFC (or Goddard): NASA's Goddard Space Flight Center, Greenbelt, Maryland.

HDDT: High Density Digital Tape.

HDT-A: High density digital tapes of either MSS or RBV data that have been radiometrically but not geometrically corrected.

Heighting: A term referring to the ability to resolve the height of objects by means of stereoscopic imagery.

IFOV: Instantaneous Field of View. The field of view of a scanning instrument with the scan motor stopped. In this document, IFOV is equated to the geometric size of the Earth-area of least size that is discernible by the sensor and which is referred to as the "resolution" of the sensor.

Interim Operational System: The land remote sensing satellite system to be operated by NOAA and based upon the Landsat D series of spacecraft and the Landsat D ground segment, including any modifications to meet initial operational reliability and performance standards.

IR-Infrared: That part of the spectrum from the red end of visible light to the microwave region; that is, from about 0.7 m to 1 mm.

IRS: Indian Remote Sensing Satellite. Proposed by Indian Space Research Organization.

LACIE: Large Area Crop Inventory Experiment. A demonstration Program (1974-1977) that used Landsat and weather data to provide estimates of wheat production.

Landsat: Land remote sensing satellites (formerly ERTS; Earth Resources Technology Satellites) of the series currently operated by NASA.

Landsat D: The next generation of NASA's land remote sensing satellites. Follow-on spacecraft of this series will be sequentially designated Landsat D', Landsat D'', etc.

LASS: The Land Applications Satellite System under consideration by ESA for a 1987/88 launch.

LOS: Land Observations Satellites being considered by Japan for 1987 launch.

Land Remote Sensing Satellite Advisory Committee: Proposed advisory committee to NOAA, with representatives from state and local governments, other domestic non-Federal users, and interested domestic private sector groups.

Maximum System: An operational land remote sensing satellite system with TM bands 1, 2, 3, and 4 at 10 meter resolution, as well as TM bands 5 and 7 at 20 meter resolution. This system would provide service at a level considerably in excess of that of Landsat D.

MERES: Mineral and Energy Resources Exploration Satellite proposed by Japan.

Middle System: An operational land remote sensing satellite system with a resolution of 30–40 meters in TM bands 1, 2, 3, 4, 5 and 7 when technologically possible, and the possible inclusion of TM band 3 at 15 or 20 meter resolution. This system would provide service essentially equivalent to the Landsat D system.

Minimum System: An operational land remote sensing satellite system providing overage in four or five bands at a resolution of 80 meters. The spectral intervals would be similar to those used in TM visible bands, 1, 2, 3 and 4 plus either TM shortwave infrared band 5 or 7—when technologically feasible. This system would provide service at a level less than that of the Landsat D system.

MLA: Multi-Linear Array—solid state technology to support the development of a new sensor on future Landsat spacecraft.

MMS: Multi-mission modular spacecraft.

MSS: Multispectral Scanner—an instrument which provides data in four bands of the visible and near-infrared portions of the spectrum. The MSS scans a swath 185 km wide and has an instantaneous field of view (IFOV) of 80 meters.

NASA: National Aeronautics and Space Administration.

NESS: National Environmental Satellite Service.

NOAA: National Oceanic and Atmospheric Administration.

NOSS: National Oceanic Satellite System.

OMB: Office of Management and Budget.

Outer Space Treaty: Outer Space Treaty is the abbreviated name for the multilateral Treaty of Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, which establishes in seventeen Articles general principles governing the activities in outer space of State parties to the Treaty in support of the use of outer space for peaceful purposes and for the benefit of all peoples. The United States is a party to the Outer Space Treaty which was entered into force October 10, 1967.

PRC (Space): Policy Review Committee on Space—established by Presidential directive in May 1978, to provide a forum for discussion of proposed changes to national space policy and for rapid referral of issues to the President for decision.

Program Board: An Assistant Secretary level body to be established and chaired by the Commerce Department for continuing Federal coordination of land remote sensing and to consider issues related to regulation and private sector establishment.

Resolution: Identical (in this document) with instantaneous field of view.

RVB: Return Beam Vidicon—cameras which essentially provide black and white TV images. Each RBV image from Landsat 3 covers an area 90 km on a side (180 km total swath) and has an equivalent IFOV of 40 meters.

Royalty Fee: A fee that could be paid by each U.S. and foreign user and foreign ground station operator on the reproduction or resale of Landsat standard data products.

S-Band: A frequency band over which MSS data are transmitted to foreign ground stations directly from the spacecraft.

Spectral Bands: Portions of the electromagnetic spectrum of energy radiated or reflected by the Earth to which spacecraft sensors are sensitive.

SPOT: Satellite Probatoire d'Observation de la Terre. This system is scheduled for launch by France in 1984 and is to contain two 3-channel multispectral/panchromatic multilinear visible spectrum array sensors. Its objectives are to develop satellite renewable and nonrenewable resource observation techniques and to develop a stereo and cartographic data archive.

Standard Data Products: Data in prescribed form that are put through additional computer processes at the satellite ground processing facility. Two classes of standard data products are currently available—film imagery, which is convenient for those accustomed to working with maps and photographs, and computer compatible tapes (CCTs). The tape form is suitable for input to standard computers and lends itself to automated or specialized data handling and analysis.

Stereo Coverage: Refers to the availability of data from which the variation in the height of the surface being viewed can be determined.

TDRSS: Tracking and Data Relay Satellite System—a communications system to be used for the relay of data direct from Landsat to a single U.S. ground station at White Sands, New Mexico.

Timeliness: The length of time between the observation itself and the delivery of suitable processed data to users or to the archive.

TM: Thematic Mapper—an instrument containing seven spectral bands, including three in the infrared region, with an instantaneous field of view (IFOV) of 30 meters for all but the thermal infrared band which has an IFOV of 120 meters.

Transmission Fee: A fee that could be paid by foreign ground station operators for data transmitted and received by the foreign ground stations, based on the amount of data requested.

USDA: United States Department of Agriculture.

USGS: United States Geological Survey (DOI).

Value added products: These are products derived from standard data products that are manipulated by computers and/or interpreted in various ways to provide information that is valuable to those who wish to make decisions involving knowledge about or changes on the surface of the Earth.

WBTR: Wide-Band Tape Recorder.

X-band: A frequency band over which a combination signal of MSS and TM data from Landsat D will be transmitted directly to foreign ground stations.

ZBB: Zero Based Budgeting.

Zone of Exclusion: An area over the Indian sub-continent and south-central USSR where direct satellite transmission to the TDRSS is physically impossible.

ATTACHMENT A

[From the Office of the White House Press Secretary, Nov. 20, 1979]

THE WHITE HOUSE

The President today announced the designation of the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) to manage all operational civilian remote sensing activities from space. This designation is one of several policy decisions announced today after a review of civilian space policy mandated by a Presidential Directive in October, 1978.

Early in his administration, the President directed a comprehensive review of space policy. The review, completed in May, 1978, resulted in a Presidential Direc-

tive that established a national space policy framework. It created a Policy Review Committee on Space, chaired by the Director of the Office of Science and Technology Policy, Frank Press. One of the tasks of the Policy Review Committee has been to assess the Nation's future civil space remote sensing requirements. That review was the basis for the policy decisions announced today.

Designation of a single agency, NOAA, to manage all civil operational satellite activities will lend itself to further integration and potential cost saving in the future. NOAA's experience in successfully operating and managing three generations of weather satellites prepares it to assume the responsibility for land remote sensing in addition to its ongoing atmospheric and oceanic activities. NOAA's first action will be to develop a transition plan in coordination with other appropriate agencies for moving to a fully integrated satellite-based land remote sensing program.

Initially, our operational land remote sensing efforts will rely on experience derived from the LANDSAT program. LANDSAT was begun in 1972 by NASA as a satellite effort specifically designed to observe surface features of the earth.

The President's decision established a three part framework to serve remote sensing activities:

Integration of civilian operational activities under NOAA.

Joint or coordinated civil/military activities where both parties' objectives can be best met through this approach.

Separate defense activities which have no civilian counterpart.

Other space policy decisions developed by this review and announced today are:

The Commerce Department will seek ways to further private sector opportunities in civil land remote sensing activities, through joint ventures with industry, a quasi-government corporation, leasing, etc., with the goal of eventual operation of these activities by the private sector.

We will continue the policy of providing LANDSAT data to foreign users, and promoting development of complementary and cooperative nationally operated satellite systems so as to increase benefits for all nations.

The Department of Commerce will establish and chair a Program Board for continuing federal coordination and regulation of civil remote sensing activities. The involved federal organizations will be represented (i.e., the Departments of Defense, Interior, Agriculture, State, Transportation, and Energy, and NASA, CIA, AID, and EPA). The National Governors' Association and the National Conference of State Legislatures will be invited to participate.

Separate weather programs for the military and civil sectors will be maintained under the Departments of Defense and Commerce because of their differing needs. We will continue procurement of current spacecraft until development of a new system design is justified. Future polar orbiting satellite development and procurement will be jointly undertaken by Defense, Commerce and NASA to maximize technology-sharing and minimize cost.

Ocean observations from space can meet common civil and military data requirements. Accordingly, if we decide to develop ocean satellites, joint Defense/Commerce/NASA management of the program will be pursued.

CHECKPOINT,
A PROJECT OF WAR CONTROL PLANNERS, INC.,
Washington, D.C., June 26, 1980.

Hon. ADLAI E. STEVENSON,
Chairman, Subcommittee on Science, Technology and Space,
Senate Office Building, Washington D.C.

DEAR MR. CHAIRMAN: Throughout history, whatever people have been able to envision, eventually they have been able to create. Presidential Directive No. 54 is the public expression of a White House devoid of vision appropriate to the clear and present danger, and dominated by special interests seeking personal profit as a higher priority than the search for national security.

The basic national security assumptions symbolized by Zbigniew Brzezinski, Henry Kissinger and Dean Rusk, etc. became outmoded in the 1960's. No President since Roosevelt has had a personal grasp of the lonely, personal, ultimate responsibility of a Chief Executive, in the creative command of American science, technology and strategic power. No current presidential candidate understands this command responsibility, and its creative opportunities.

The man or woman who will deliver the Inaugural Address January 20, 1981 will possess (with his or her counterpart in the Kremlin) the power to rupture or destroy world civilization, a power human beings have no successful precedent for wielding.

The phenomenon of War-Peace-War-Peace-War has plagued all human history, killing almost as many human beings as smallpox did. In recent times a "miracle" was performed and today the plague of smallpox has been brought to an end, worldwide. No similar effort has been made to bring the "endless" cycle of War-Peace-War-Peace-War under positive control. If this epidemic breaks out once more (as it is showing signs of doing with inept White House threats of 'military action') this could bring an effective end to world civilization for a thousand years. Only a 'miracle' may avert approaching world tragedy and chaos.

Modern management has learned how to direct advancing science, technology and management skills to perform 'modern miracles'. What writers of Ancient Scriptures would have dared tell the tall tale of the miracle performed by a powerful King as he instructed several of his subjects to go to the Moon, taking their automobile with them, and a camera through which people all around the world could witness the explorations, in real time?

President Roosevelt and Congress, through one channel of command (1) prosecuted World War II, while simultaneously through a different channel of command (2) unleashed the creativity and power of America for a creative experiment in the Manhattan Project, to perform the "miracle" of releasing the power of the atom.

President Kennedy and Congress refocused public opinion away from the Cuban Invasion fiasco by the unprecedented commitment of American creativity and power to a ten year challenge to make the Moon safe for human visits.

The Inaugural Address on January 20, 1981 could electrify world populations on both sides of all confrontations by a historic commitment by the Preident of the United States and the Congress to a ten, twenty or thirty year challenge of (1) meeting all requirements for national defense and in addition (2) leading the world in research, development, pragmatic testing and experimental operation of world-sized systems, management structures and legal institutions to make Planet Earth safe for human futures in all nations, free from war and free from want.

For the first time in history advancing science and technology and management skills (knowledge and skills in all fields) have reached the point where such a creative commitment is feasible, and prudent.

A President and a Congress appropriate to the peril beginning to engulf America and the world, could put to work America's great national asset—the global systems professions and industries, doing what they do best . . . pioneering utterly complex global experimental systems, providing world leadership in support of Life and Hope in all nations (in contrast to present leadership in weapons of death, destruction, obliteration and extermination). Once more it could be a matter of bursting pride to be an American!

Our files are filled with documentation that this has been a "Forbidden Subject" in the White House under Presidents Johnson, Nixon, Ford and Carter dominated by financial/industrial interests finding protracted personal prosperity from protracted conflict, thriving on the escalating (runaway) arms race.

In the field of The Common Defense, the Constitution attempted to provide a "fail-safe" instrumentality, in case of the failure of the Presidency: The Congress. But in this area of making creative use of America's temporary lead in global systems technologies, the Congress today is in a state of inner chaos, rampant confusion and uneducated impotence.

I am not a lobbyist. I am not seeking your support for legislation or political action. Through the following gross oversimplifications I would hope, through you, to spark widest possible pro and con and creative discussion in the entire Senate (and in the House of Representatives) spreading into professional and public discussion, and an agonizing reappraisal of U.S. world power objectives.

Space science and technology have caused Space Power to become the leading edge, setting the pace for all other U.S. power systems. It is difficult to think of a more appropriate platform than your Subcommittee on Science, Technology and Space, to break open the discussion of a New American Purpose, and a national dialogue on Space Power in the Service of Life and Hope for the people of all nations.

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(Document C) "A Global Information Complex" published first in the record of the 1975 hearing on "Future Space Programs" by the House of Representatives Subcommittee on Space Science and Applications. Republished in June 17, 1979 issue of Aerospace and Electronics Systems Society Newsletter. Republished again by the Pentagon press review service and disseminated to all military and civilian leadership in the Defense Department, world-wide.

[1]The material comprising the above index is in the Committee's files.

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